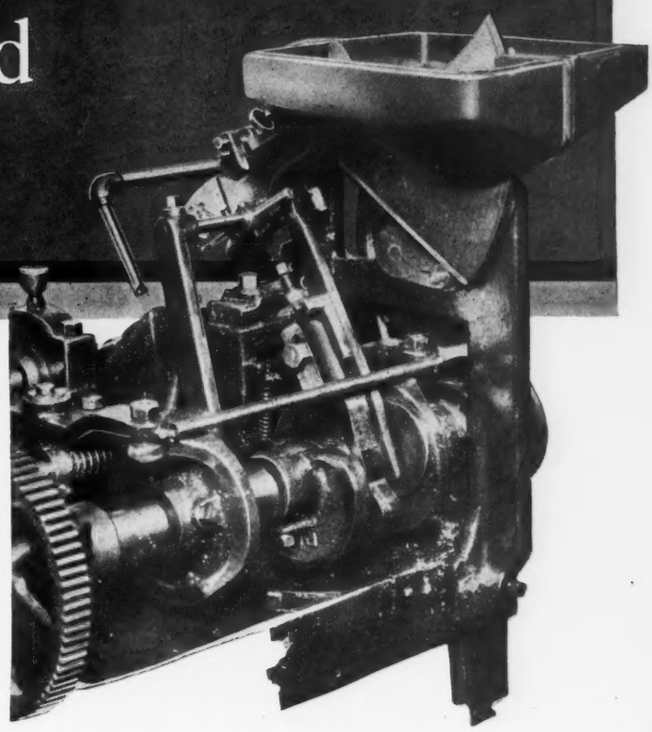
Magazine Feed Mechanisms



A Description of Mechanisms and Mechanical Movements Used in the Design of Magazine Feeding Devices for Automatic Machines Employed by the Diamond Chain & Mfg. Co.

By EDWARD K. HAMMOND

MANY successful manufacturers have found it profitable to group machines that are used for the quantity production of duplicate parts, with a single operator to look after an entire group. Several benefits are secured from such a method of procedure, most important of which is the saving of labor costs that is effected. This method is also the means of increasing rates of production and reducing the idle time of the machines and operators, if the application of this principle has been worked out to the best possible advantage. No special equipment is needed, in cases where the length of time required to complete the operation performed by each machine is sufficient to allow the attendant to follow a predetermined routine in going from one machine to another, removing finished pieces and setting up fresh blanks in their place. But if the length of time required to perform each individual operation is very short, it is often necessary to equip each machine of such a group with some form of magazine feeding device which automatically delivers blanks to the machine as fast as the operations are performed and finished pieces ejected. Otherwise, it would be obviously impossible for a workman to look after more than one machine without having a prohibitive amount of idle time charged against all such machines in the group.

In the present article it is intended to illustrate and describe a number of ingenious magazine feeding devices which have been developed at the plant of the Diamond Chain & Mfg. Co., Indianapolis, Ind., for use in handling parts of the sprocket chains manufactured by this firm. Many of the machines and the feeding devices used on them are of a special character, and have been designed to meet the requirements of some unusual job; but these mechanisms are called special because their designs have been adapted to the peculiar requirements of individual jobs, and not due to the fact that the basic principles of their construction and operation are only fitted for the requirements of one operation. As a matter of fact, most of these principles are entirely general, as regards their possibility of application, and for that reason men who are engaged in designing special tools to meet the requirements of a great variety of manufacturing operations will see possibilities for the employment of similar devices for handling parts of their own product.

Conditions to be Considered in Designing Magazine Feed Mechanisms

A designer who undertakes the development of magazine feed mechanisms with a reasonable chance that his work will eventually be the means of effecting substantial reductions in production costs must bear in mind the fact that the purpose of such equipments is to enable an attendant who is assigned to look after a number of machines, to periodically furnish each one with a supply of blanks sufficient to allow it to run for a considerable period of time without further attention. If the special equipment which the designer puts on a machine for this purpose is not perfectly designed, the transfer of blanks from the hopper to the cutting tools may be stopped, and this will often result in a serious loss of output on a machine that is so affected, because the attendant may not notice that production is not continuing until such a time as his regular round leads him back to the machine in question.

Precautions taken to overcome such difficulties will depend upon the nature of the work and of the operation to be performed, but as a general proposition, it may be stated that great care should be taken to provide an efficient form of agitator to stir up the blanks in the hopper and to assure their uniform delivery to the feed-chute or other means of transferring them from the hopper to the tool. Care must also be taken to so proportion and arrange the feed-chute that there is no danger of blanks becoming clogged in it. Another precaution is that of examining the condition of the work as it is left by the preceding operation. For instance, there may be burrs or other irregularities on the blanks which will retard their uniform feeding through an automatic mechanism, and in such cases it may be possible through a slight and inexpensive modification of the way in which the preceding operation is performed to bring the blanks to a condition where they will run uniformly from the magazine to the tools that perform the following operation.

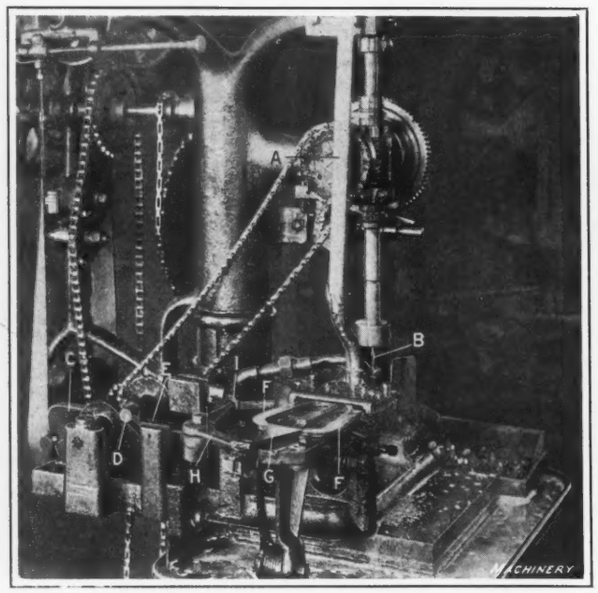


Fig. 1. Drilling Machine equipped with Automatic Magazine Feed, Transfer Slide, and Chucking Mechanism for holding the Work during the Drilling Operation

Feed Mechanism on Center Block Drilling Machine

For use in drilling rivet holes in the center blocks for bicycle sprocket chains, a battery of drilling machines is employed, built by Norton & Jones; but in order to adapt them for their peculiar work, the original design has been greatly modified, including the application of an interesting magazine feed mechanism shown in Figs. 1 and 2. The blanks to be drilled are fed to the work-holding fixture on the machine from a feed-chute *A* and as there are two holes to be drilled in each blank and only a single drill *B* is employed for the performance of this operation, it will be apparent that each piece must be reset after drilling the first hole, in order to locate it in the proper position for drilling the second hole. The feeding of each successive blank to the machine and the indexing of the work for drilling the second hole are automatically controlled by means of a cam-actuated mechanism, and after the finished work has been drilled, it is automatically ejected and another blank delivered to the fixture ready for the following operation.

The mechanism by which these results are accomplished may be briefly described as follows: At the back of the machine there will be seen a cam *C* which receives its motion from a sprocket chain drive. Carried by arm *E* there is a roller *D* that runs in contact with the cam. A pivotal support carries the entire fixture that holds the work to be drilled, so that connection of one end of the fixture with arm *E* results in swinging the fixture around this pivot in order to bring the opposite end of the work into position for drilling the second hole, after the first drilling operation has been completed. Reference to the form of cam *C* will make it apparent that two circular portions or dwells are provided, which allow the work-holding fixture to remain in a stationary position while either of the two drilling operations is in process. After the first operation is completed and the drill has been raised out of the hole, a rise on the cam between the smaller and larger sections of circular form results in pushing forward roller *D* and arm *E*, and thus swinging over the work-holding fixture in order to bring it into position for receiving a fresh blank. After the first hole has been drilled in a blank and the drill withdrawn from the work, roller *D* comes into engagement with a drop on the cam between the larger and smaller circular sections. Consequently the roller runs down the cam and allows arm *E* to move backward, thus swinging the fixture over into position for drilling the second hole in the work.

Jaws of V-form hold the work while it is being drilled, and secured to these jaws there are two fingers *F* which have their back ends in contact with a triangular shaped block *G*. When this block is pulled back to the position shown, it causes fingers *F* to swing about their pivotal supports so that the front ends of the fingers, which are in contact with the jaws, move inward and securely grip the work. After the second drilling operation has been completed and it is required to release the work, this result is accomplished by pushing triangular block *G* forward in order to allow a spring to draw the back ends of fingers *F* together. Block *G*, which controls the opening and closing of the work-holding jaws, is controlled by means of a bellcrank *H* that has a hook at its rear end, which is engaged by a second hook *I*. As roller *D* runs up the rise on cam *C*, it will be apparent that bellcrank *H* will also be pushed forward, because the pivotal support of this link is carried by a boss on the work-holding fixture which is caused to swing by the cam movement. It must be understood that hook *I*, which engages the hook on the back end of bellcrank *H*, is not connected to the work-holding fixture, and so it will be apparent that the forward movement of the bellcrank will result in pulling the bent end of the bellcrank under hook *I*, the only way in which this result can be accomplished being to push the opposite end of bellcrank *H* inward, thus causing the sliding triangular block *G* to move between the ends of fingers *F*.

Secured to block *G* there is a transfer slide or pusher, which is made just enough thinner than the blanks carried in feed-chute *A* to afford clearance. This pusher normally rests beneath the column of blanks in chute *A* and holds them up in place, but as cam-block *G* moves back to close the jaws for a drilling operation on a blank that has just been advanced into position, the pusher slides out from under the column of blanks and allows one to drop. Then on the next forward stroke of the pusher it engages the side of the bottom blank and advances it into place for drilling, while the pusher, on account of its thickness being less than that of the blanks, is able to slide under the next blank carried in feed-chute *A*. This cycle of operations proceeds automatically, and as a result it is only required for the attendant to put loaded feed-chutes into place and remove the empty tubes. One cheap girl operator is able to look after a number of the machines and also attend to loading the feed-chutes on the machine shown in Fig. 5.

Feed Mechanism for Center Block Reaming Machine

Use is made of single-spindle drilling machines equipped with two spindle heads, to provide for simultaneously reaming the four holes in two bicycle sprocket chain center blocks, and in Figs. 3 and 4 there is illustrated the means employed for feeding these parts to the machine. In this case the device used may be styled a combination hopper and

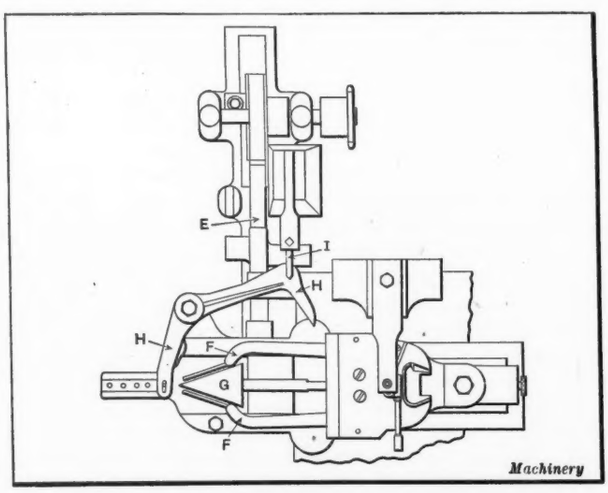


Fig. 2. Plan View of Transfer Slide and Chucking Mechanism on the Drilling Machine shown in Fig. 1

feed-chute, as it serves the double purpose ordinarily accomplished by two separate members. The work to be reamed is shown at *A*, and will be seen to consist of blocks made of steel, the cross-section of which is similar to the shape of a figure 8 with a hole through each lobe. These blocks are strung on U-shaped wires which are termed "hair pins" in the Diamond Chain & Mfg. Co.'s plant. These are held in a vertical position as shown, and the blocks slide down by gravity and are received by an automatic transfer mechanism which carries them across from the base of the wires to the chuck. The way in which this result is accomplished is as follows: Cam *B* engages the end of a cross-slide *C* that carries two vertical cam-rollers *D*. These rollers run in inclined grooves in plates *E*. As cam *B* pushes slide *C* toward the left, rollers *D* move in their inclined grooves and push plates *E* forward.

In the plan view of the mechanism shown in Fig. 4, it will be seen that each of the magazines delivers blanks at the points *F*, and sliding beneath the stack of blanks supported by each hopper there is a transfer slide *G* secured to the corresponding plate *E*. As plate *E* is pulled back, slide *G* is withdrawn from beneath the stack of blanks, allowing them to drop down on the bed of the fixture and then, as the slide moves forward on its return stroke, it pushes out the bottom blank and advances it to a position between the chuck jaws, which are V-shaped. In order to accomplish this result, the transfer slide is made slightly thinner than the blanks to be handled. The chuck jaws are secured to the ends of pivoted arms *H* which are normally held open through the tension of springs. It will be seen that on their outsides, these jaws are tapered to correspond to tapers on the inner sides of the openings in plates *E*, and as the plates are drawn back the tapers engage the corresponding fits on jaws *H* and force them inward, so that the V-blocks obtain a secure grip on the work. Each time the transfer slides *G* move forward they not only carry two blanks to positions where they can be gripped by the jaws, but also push out the blocks that were reamed by the preceding operation. The action of the mechanism is entirely automatic, thus reducing to a minimum the amount of attention which the machine requires from the attendant.

Method of Loading the U-wires

Anyone who gives at all careful thought to the question of employing a U-wire chute for feeding blanks to a machine is likely to ask the question: "How can the U-wires be quickly loaded with blanks?" It is found that this can be very simply and rapidly done by using a long-tined fork which is thrust into a container holding a large number of drilled blanks. The tines of this fork go through the holes in a large number of blanks and enable them to be quickly gathered up, but it is important to note that the spacing of the tines is such that it is impossible for two of them to go

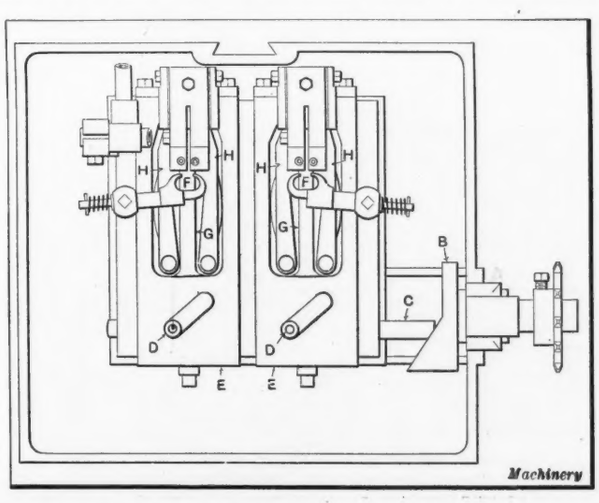


Fig. 4. Plan View of Transfer Slides and Chucking Mechanism on the Machine shown in Fig. 3

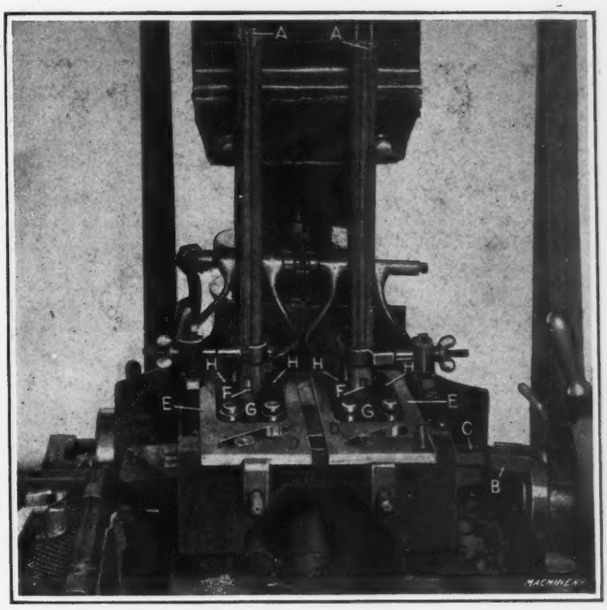


Fig. 3. Single-spindle Drilling Machine equipped with Two-spindle Head, U-wire Type of Blank-feeding Device and Cam-operated Automatic Chucking Mechanism

through two holes in the same blank. As a result the fork is lifted out of the container with a row of blanks suspended from each tine, and the girls employed to do this work have learned by experience to take a row of the blanks between their thumb and index finger and draw them off the fork with the holes in perfect alignment so that the blanks can be readily dropped over the legs of the U-wire. Experienced girls devote all their time to loading these U-wires which are then taken to the machines and set in racks ready to be put in place for delivering blanks to the machine as they are required.

Feed-chute Loading Machine

For use on machines of the type shown in Fig. 1, which are employed for drilling holes in bicycle chain center blocks, and for the performance of other operations where the work has no holes in it to provide for the use of the so-called "hair pins" or U-wires, tubular feed-chutes made to conform to the shape of the blanks can often be successfully employed. The method of using this type of carrier is the same as that governing the operation of U-wires, except that the chute embraces the periphery of the work instead of having two wires passing through holes in the blanks. In Fig. 5 there is shown a simple machine that provides for quickly loading these feed-chutes. One of the chutes is shown on the loading machine, suspended horizontally at *A*, and hopper *B* contains a quantity of the blanks to be placed in the chutes. The blanks pass down from hopper *B* through a chute *C*, which is so proportioned that it is only possible for the blanks to enter endwise, and with the axes of the two lobes of the blank in the desired position. Surrounding the feed-chute there is an agitator *D* consisting of a sleeve that embraces the chute and receives an oscillating vertical movement by means of a three-lobed cam *E*, from which power is transmitted through a cam-roller *F* secured to link *G*, which is connected to the agitator *D*.

Rotation of cam *E* keeps the agitator continually moving up and down, and thus stirs up the blanks and insures a constant flow of them through the chute *C*. Carried on the same shaft with cam *E* there is a cam *H* from which movement is transmitted to a transfer slide. At the back end of bellcrank *I* there is a cam-roller carried by pivot *J;* and at the front end of the same link, pivotal connection is made with a transfer slide which is of such a size that it just runs in slot *K*. Coiled spring *L* holds the front end of bellcrank *I* forward, thus keeping roller *J* in firm contact with cam *H*. The bellcrank is pivoted at the center and through the oscillating movement imparted by cam *H*, a similar reciprocating

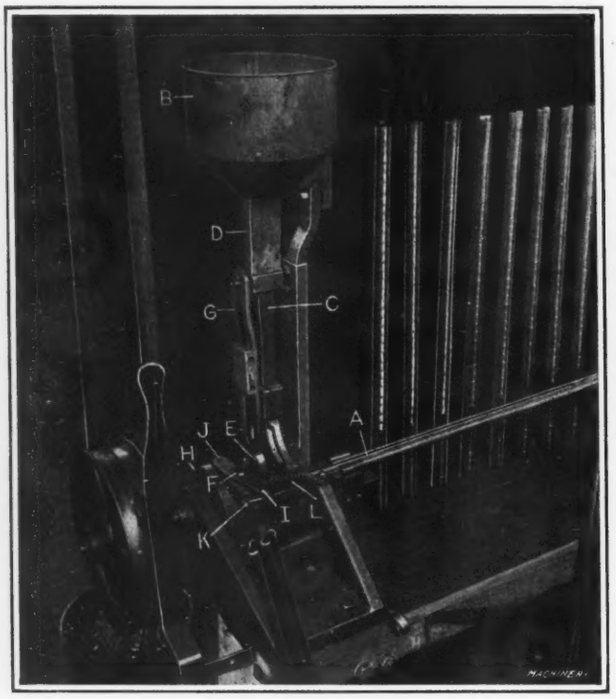


Fig. 5. Automatic Machine for loading Solid Blanks into Tubular Feed-chutes of the Kind shown in Use on the Drilling Machine shown in Fig. 1

movement is imparted to the transfer slide running in slot *K*. As a result blanks slide down chute *C* and are pushed forward into the horizontal feed-chute *A* by means of the slide, thus enabling the chutes to be quickly loaded and stood up in a rack at the back of the machine, where a supply of loaded ones is kept, pending their being needed for use on the machines to which they are to feed blanks.

U-wire Loading Machine

In some types of sprocket chains made by the Diamond Chain & Mfg. Co., there are three different members in each cross-bar of the chain, namely, a central rivet, a bushing surrounding the rivet, and a roller that fits over the bushing and comes into actual contact with the sprocket teeth. For feeding these rollers to machines that are used for performing machining operations on them, use is made of U-wires similar to those employed for reaming blocks as shown in Figs. 3 and 4. The smaller sizes of rollers are of light weight, and it has been found possible to employ an ingenious method for loading them on U-wires which hold a column of rollers on each leg of the U. The apparatus employed for this purpose is illustrated in Fig. 6 and the name "Merry-go-round" has been applied to it. This name will give the reader a clue as to the manner in which the apparatus operates. It consists of a pan that has a stationary wall to retain the bushings contained in it, while the base revolves, being driven by belt *A*. The U-wires *B* to be loaded are supported in an inclined position, and as the base of the pan revolves it carries the rollers around with it, forcing them up on the U-wires which can be very rapidly loaded by this method. The rim surrounding the rotating base is made a separate part and held stationary in order that an opening *C* may be cut into this member to allow the wires to be inclined at a very gradual angle, as the more nearly horizontal the position in which they are held, the more rapidly will the rollers be run up on the wires.

Use of Sprocket Wheel as a Transfer Slide

Figs. 7, 8, and 10 show a machine used for countersinking bushings and rollers for sprocket chains, and the form of magazine feed mechanism with which this type of equipment is provided. So far as the feed hopper and agitating mechanism are concerned, the general arrangement is similar to that shown on the machine illustrated in Fig. 5, although there is a slight difference in the way in which power is transmitted from the cam to the agitator. This is made quite clear by the illustrations, so that a detailed description is uncalled for. The feed-chute leading from the hopper makes a quarter turn to bring the blanks carried by it into a horizontal position; and these blanks enter spaces between the teeth of a sprocket wheel *A*, which carries them into place for the countersinking operation. Referring to Fig. 7, attention is called to cam *B* which operates a ratchet and pawl to provide for indexing sprocket wheel *A*, to cam *C* that operates the agitator on the magazine, and to cam *D* which applies pressure for holding down the work while the countersinking operation is in process. Located beside the work-carrying sprocket wheel *A* there is a ratchet wheel which is engaged by a pawl carried at the inner end of lever *E*, to provide for indexing wheel *A* to carry the work from the feed-chute into position between the opposed countersinking tools. Lever *E* carries a cam-roller at the outer end, that runs in contact with cam *B*, and each time the rise of this cam causes a movement of lever *E* it advances the sprocket wheel *A* through two tooth spaces and brings two new pieces of work into position to be countersunk.

During the time that the countersinking operation is being performed, it is necessary to have the work securely held against movement and this result is accomplished by means of cam *D* and lever *F*. When the two blanks have been advanced into position between the countersinking tools, cam *D* swings lever *F* downward, and this brings a notched clamp down on the work, thus serving the double purpose of holding the work in place in the sprocket wheel and preventing the wheel from turning. It will, of course, be apparent that the agitating mechanism keeps the chute constantly full of blanks and these come down and abut against the sprocket wheel. The thickness of the wheel is slightly less than the length of the pieces of work, so that a blank can drop into place in a tooth space and be carried away, allowing the following blank to drop into the next space in the sprocket wheel, this sequence of movements being continued indefinitely. Fig. 8 illustrates in greater detail the arrangement of the magazine feed and auxiliary mechanism on a countersinking machine of similar design to the one shown in Fig. 7, except that it is arranged to handle only one piece of work at a time; and Fig. 10 shows details of the work-clamping device and agitator for the magazine, which are used on this machine. Another form of magazine feed agitating mechanism for use on a countersinking machine of this type is shown in Fig. 9.

Hopper Feed Mechanism on Rivet Countersinking Machine

In Figs. 11 and 12 there are shown front and rear views of a special machine built by the H. P. Townsend Mfg. Co., of Hartford, Conn., for use in countersinking the ends of rivets used in assembling Diamond sprocket chains. This machine is provided with an unusually interesting hopper feed mechanism and means of transferring blanks from this hopper to a position between the spindles. It will be apparent

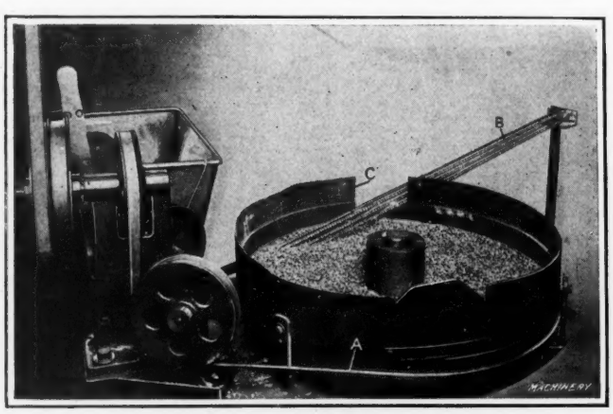


Fig. 6. "Merry-go-round" Device for loading Work on U-wire Magazines

that contained in the hopper there is a crescent-shaped agitating and elevating member *A*, which is caused to rise and fall through the action of a cam. This plate descends below the surface of the rivets in the hopper, which are of quite small size, and then rises with a number of rivets held in a groove along the top edge of the plate. As the cam continues to raise the elevating member *A*, the incline of the groove cut in its upper edge becomes more abrupt, until finally frictional resistance is overcome and the rivets held in this groove slide down into a feed-chute located at *B*. At the end of this feed-chute there is a quarter-round dial plate *C* which also has an oscillating movement imparted to it, and at the right-hand edge of the quadrant a groove is cut to receive one of the rivets *D* each time that the groove in the quadrant comes into position opposite the end of feed-chute *B*. This quadrant takes the rivet and carries it down until the right-hand edge of the quadrant, as shown in Fig. 11, is in a horizontal position. At this point a spring clip *E* carried by arm *F*, is pushed down over rivet *D* and lifts it out of the transfer quadrant. The clip then descends again until it reaches a position where the rivet can be grasped by the jaws of chuck *G*, ready to have the countersinking operation performed.

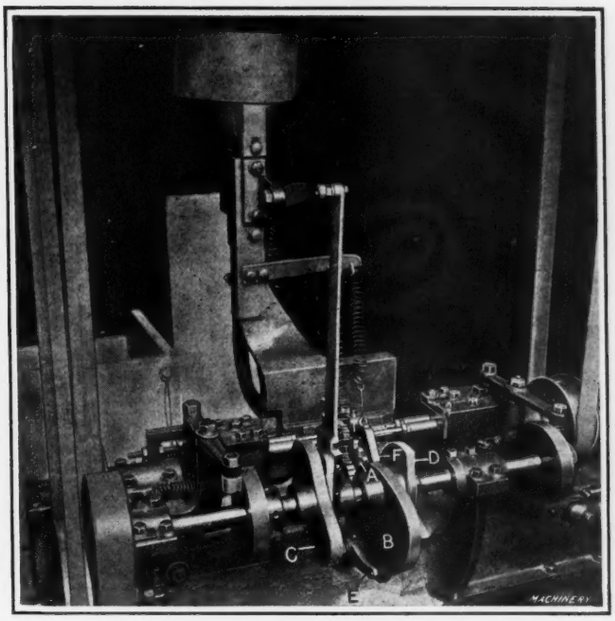


Fig. 7. Countersinking Machine with Chute to carry Blanks from Hopper to Sprocket Wheel that serves as a Substitute for a Transfer Slide

It will be apparent to any mechanic who has had experience with the use of automatic machinery that the timing of various parts of the mechanism of a machine of this kind must be very carefully worked out in order to have all of the movements properly synchronized. This result is accomplished through the medium of a camshaft extending along the back of the machine as shown in Fig. 12, by means of which the different parts of the mechanism are operated. It will be seen by reference to this illustration that there is a crank *H* carrying a cam-roller *I* that runs in contact with the under edge of the agitating and elevating plate *A*. Through the action of cam-roller *I* on the under edge of the elevating device, an oscillating motion is provided as previously described. The transfer dial *C*, Fig. 11, is carried on a shaft; and in Fig. 12 it will be seen that at the back end of this shaft there is a short crank from which a connecting-rod *J* runs down to an eccentric carried on the main camshaft. In this way an oscillating movement is imparted, which is transmitted from the eccentric through the connecting-rods, crank, and supporting shaft to the transfer dial, to provide for taking blanks from the delivery chute *B* and carrying them down into position to be picked up by the spring clip *E* that transfers the work to the chuck. This spring clip is carried at the upper end of a bellcrank lever *F*, at the lower end of which there is a cam-roller that runs in contact with cam *K* on which there are two rises and two low spots. The result is that this cam causes the spring clip to first advance to pick the blank *D* out of transfer dial *C*, after which the spring clip recedes from the dial and again advances far enough to deposit the blank in place in chuck *G*. There is another cam on the shaft which provides for opening and closing the chuck in unison with the other parts of the mechanism.

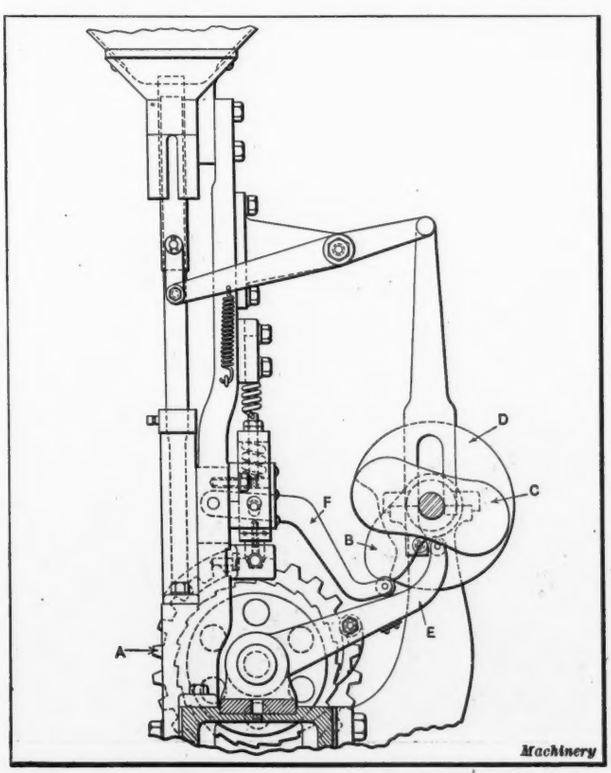


Fig. 8. End Elevation of Automatic Blank-feeding Mechanism on a Countersinking Machine

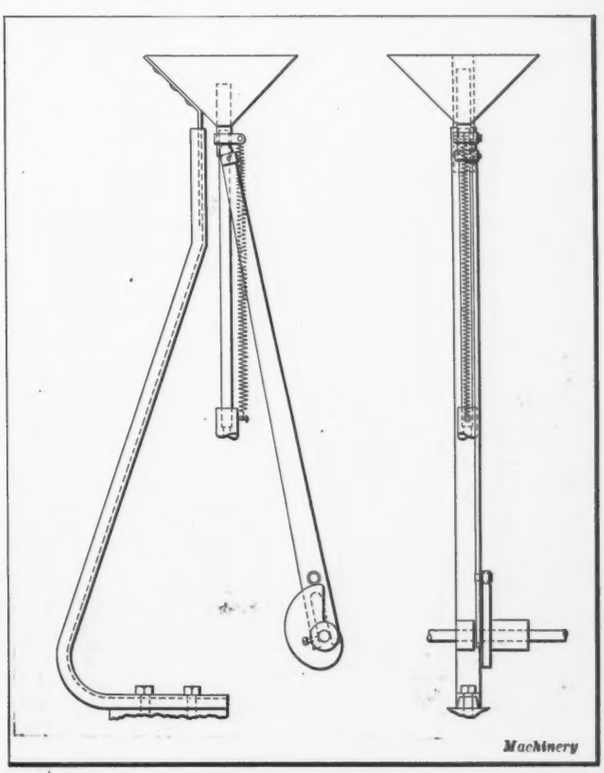


Fig. 9. Cam-actuated Agitator for Use in Blank-feeding Hopper of Countersinking Machine

Loading Pierced Blanks on Magazine Wires

Fig. 13 illustrates a power press equipped with a follow-die for use in first piercing two holes in ribbon stock and then blanking out a sprocket chain side plate from the material surrounding the two pierced holes. In a subsequent operation it is required to bevel the rough edge of these side plate blanks, that was left on the "break-out" side of the work, that is, where the blank is pushed out of the strip of steel. Machines used for performing this beveling operation are equipped with the U-wire or so-called "hair pin" type of magazine, and a great deal of time would be required to take the small pieces of work and load them on the U-wires with the break-out side of each piece at the top. To overcome this loss of time and lack of efficiency, a practice is made of having the power press on which these pieces are blanked out arranged with a magazine, as shown in Fig. 13, so that as each blank drops through the die it will be picked up on the U-wire at *A*. The press is equipped with a twin die so that two pieces of work are blanked out at each downward stroke of the ram, and so there are two wires to catch the work.

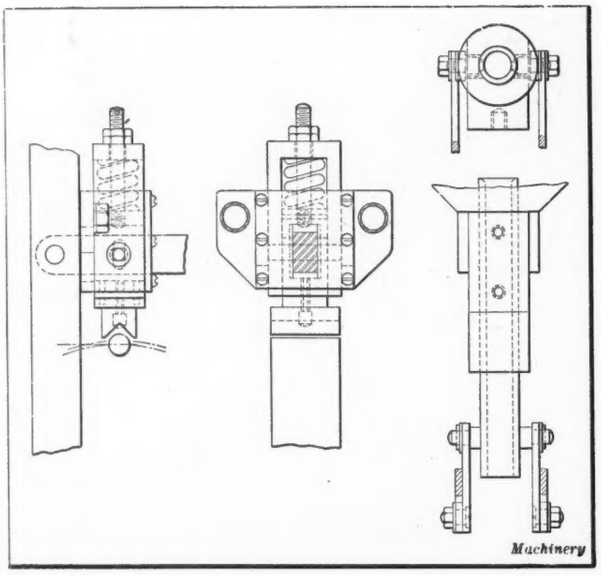


Fig. 10. Work-clamping Mechanism, and Agitator used on Machine shown in Fig. 8

A very simple method is utilized for supporting the U-wires in such a position that the blanks will drop over them. Immediately beneath each opening in the blanking die there is a pocket of sufficient size to hold a column of blanks about 3 inches in height, the pocket being arranged to stack these blanks with the holes in accurate alignment. At the bottom of each pocket there are two spring fingers with tapered sides, that are held against the bottom blank with sufficient tension to support the weight of the column of blanks in the pocket, although the spring tension will relax and allow the fingers to move back and drop the bottom blank when pressure is applied to the top of the column of blanks by the ram of the press engaging the top blank of the column when the pocket becomes filled. The column of blanks that are always held in each pocket with the holes in alignment, serves as a guide for the two legs of the U-wire which are pushed up to enter these holes. Then at each downward stroke of the press one blank is cut out of the ribbon stock and a continuation of the downward stroke of the ram applies pressure to the top of the column of blanks held in the pocket beneath the die, thus pushing the bottom blank of the column through the spring fingers which allow it to drop down on the U-wires. A short column of blanks will be seen at *B* in the illustration on each of the U-wires.

A machine equipped with an automatic feed mechanism and follow-die blanks out the work without requiring attention from the operator, and with an equipment of the kind just described it also loads the magazines ready for the blanks to be passed through the next operation that is required. There is, however, one point to which attention is called, namely, that for the following operation the blanks must be held on the U-wires with the break-out side at the top. It is for this reason that each loaded U-wire, as it comes from the machine shown in Fig. 13, is taken to a tray, Fig. 14, where the press operator very carefully withdraws the wire, leaving a row of blanks lying on edge with the holes in accurate alignment. These trays are then transferred to the next machine, when it is a simple matter for the operator to push the U-wires in from the opposite end, thus enabling the column of blanks to be set up on the machine with the break-out side at the top. Were it not for the necessity of turning the work over, it would be more convenient to have a sufficient supply of U-wires so that the columns of blanks and the

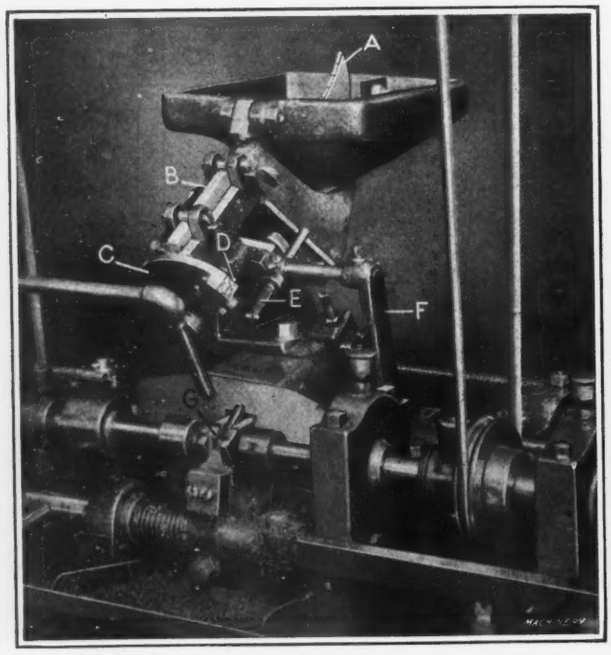


Fig. 11. Front View of Countersinking Machine furnished with an Unusually Interesting Hopper, Feed-chute, and Transfer Mechanism for delivering Work to Tools

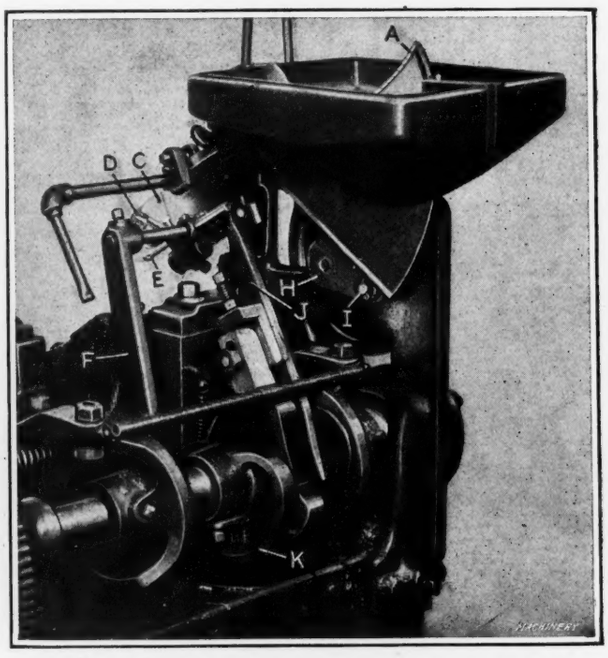


Fig. 12. Rear View of Machine shown in Fig. 11, illustrating the Arrangement of Cams and Auxiliary Links for actuating the Agitator and the Transfer Mechanism

wires could be sent right along from the machine on which the magazines were loaded to the next machine on which they are to be used.

Power Press with Magazine Feeding and Magazine Reloading Devices

It is often desirable to equip a power press with a magazine feed mechanism for delivering blanks to the dies, and if the next operation to be performed on the work is of a character where a magazine feed can be successfully employed, much time may also be saved by reloading the work into a magazine for delivery to the next machine. Figs. 15 and 16 illustrate a power press used by the Diamond Chain & Mfg. Co. which is equipped in the manner to which reference has just been made. At the front side of the machine shown in Fig. 15 there is a magazine *A*, from which blanks are carried by a transfer mechanism to a position between the upper and lower dies that perform a cold-forging operation to bevel the edge of the work. After this result has been

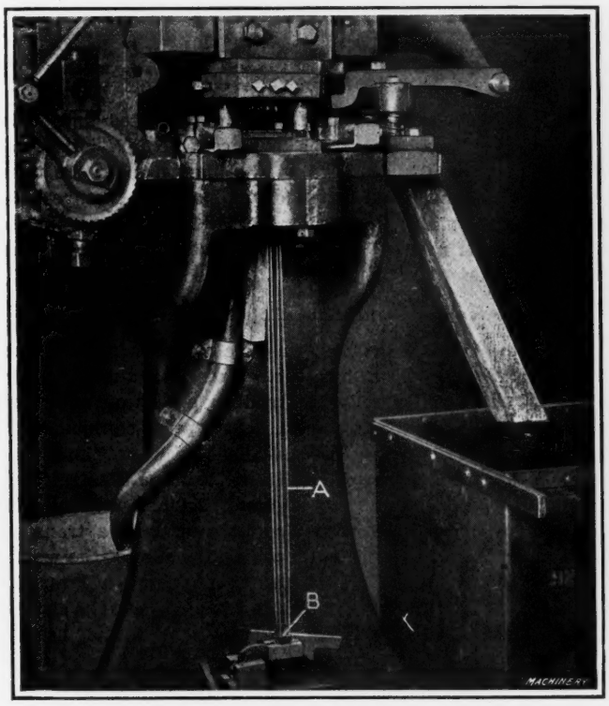


Fig. 13. Power Press equipped with Device for automatically loading Blanks on U-wire Magazine as they drop through the Blanking Dies

Fig. 14. Arranging Blanks from Machine shown in Fig. 13 in Trays Ready for Delivery to Machine for performing Next Operation

accomplished, the transfer mechanism carries the blank over to a position beneath the hopper *B*, which is shown at the back of the machine in Fig. 16, where suitable mechanism is provided to pick the blanks up and elevate them into this hopper.

Having made a preliminary statement of the way in which the auxiliary equipment on this power press functions, we are in a position to present a detailed explanation. Coupled to the end of the main shaft on the press there is a slotted crank that imparts an oscillating motion to a connecting-rod shown at *C* in Fig. 16, and this rod, through a link mechanism *D*, imparts an oscillating movement to a slide that actuates the transfer mechanism.

In order to provide for carrying over blanks from feed-chute *A* to the dies, a pusher which is connected to the oscillating slide moves back and forth under the column of blanks. The thickness of this pusher is slightly less than that of the work, and as it moves out from under the blanks, the entire column drops into contact with the bed of the fixture; then on the next forward stroke, the end of the pusher strikes the side of the bottom blank and pushes it forward into position for the dies to perform their cold-forging operation. An approximate location is provided by the pusher, after which the blank is accurately located between the dies by means of two V-shaped jaws carried by cross-slides. These jaws engage opposite ends of the blank and locate it accurately so that the die will come down and bevel the edge.

An interesting method is employed for actuating the opening and closing of these jaws, this result being accomplished through the influence of a friction washer that is tightened sufficiently to retard the sliding movement of the pusher that transfers blanks from the chute to the dies. Attention is first called to the general outline of the mechanism shown in Fig. 15 where it will be seen that there are two bellcranks *E* which are supported by pivots *F*, so that as they swing about these pivotal supports the opposite ends of the long arms move away from each other and, through the action of crossed arms, carry the V-shaped jaws inward to engage the work in the manner to which reference has been made. The pusher that carries the blanks into the dies is not shown.

After the pusher has carried a blank into approximately the desired position between the dies and has started on its return stroke, movement of the reciprocating parts of the mechanism is retarded by the frictional resistance furnished by a screw *G*, and the fiber washer beneath this screw which is tightened on the top of sliding bar *H*. There are two links *P* which project through from the actuating mechanism at the rear of the machine, these links being connected to the ends of a block that is free to slide in the frame of the fixture. The movement of this block actuates the mechanism. Owing to frictional resistance imparted by screw *G* and the friction washer beneath it, there is a tendency at the beginning of the return stroke of the pusher, for links *P* to cause a slight movement of the block to which they are secured, rather than for bar *H* to slide. This results in imparting a forward movement to pivots *F* on which bellcranks *E* are mounted, while sockets *I* at the corner of the bellcranks, which receive the two ends of a cross-member on bar *H*, are held stationary, with the result that the long ends of bellcranks *E* are caused to move away from each other. Owing to the high ratio between the long and short arms of bellcranks *E*, a very slight movement of pivots *F* relative to sockets *I* imparts a sufficient movement to the opposite ends of the bellcranks to enable them to move the V-shaped jaws through a sufficient distance to locate the work. The long ends of the bellcrank arms move away from each other,

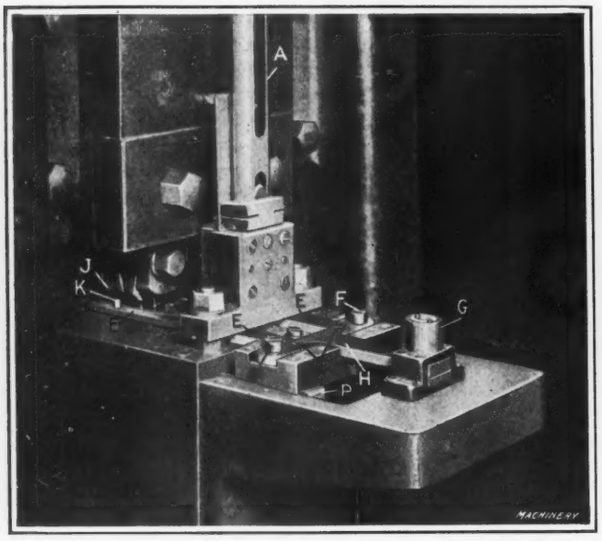


Fig. 15. Front View of Power Press equipped with Feed-chute and Automatic Transfer and Chucking Mechanism for locating the Work between the Dies

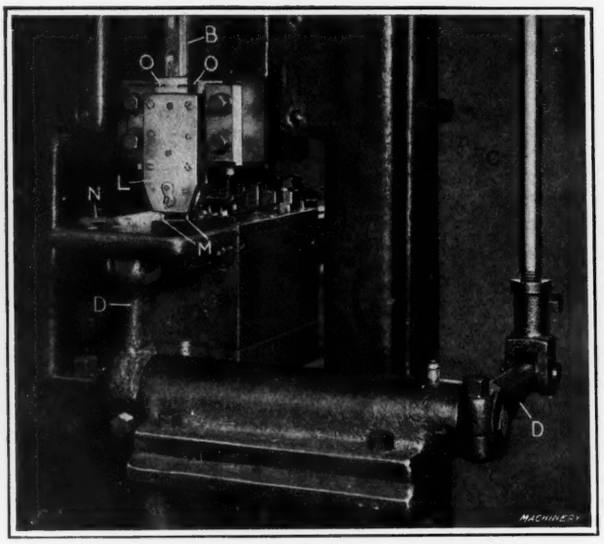


Fig. 16. Rear View of Machine showing Link Mechanism for actuating Transfer Slide and Tubular Hopper into which Blanks are automatically elevated

and for this reason it will be evident that links extending from these arms to connect with the V-blocks must overlap so that each link connects its bellcrank arm with the V-block at the opposite side of the fixture from the arm that pulls it into contact with the work. After the V-shaped jaws engage the work, further movement of the driver is made possible by the sliding of bar *H* under the friction washer at *G*.

After the operation has been performed on a piece held in the die, it is necessary to reload it into the magazine *B* at the back of the machine (Fig. 16) in the manner to which reference has been made. The transfer slide carries the work across to a position under this magazine, and secured to the bottom of the magazine tube there is a supporting box or bracket *L* that oscillates up and down with the ram of the press. Inside of this bracket there are two latches *M* which are carried on pivots, so that as the entire mechanism comes down with the ram of the press, the tapered inner faces of the latches slide over the piece of work to be picked up. These latches swing back on their pivotal supports against spring tension until such a time as the shoulders on the latches are reached. Then the spring tension causes the latches to snap in under the work and as the ram of the press rises the work is picked up. The latches just described support the entire column of blanks inside of feed-chute *B*, and after the chute has been completely loaded and it is required to put an empty tube in place, a gate *N* is slipped into the notches *O*, thus holding the blanks up in the tube so that it can be easily lifted off and an empty tube substituted in its place. Reference to Fig. 15 will show that a similar form of gate is used to hold the work in the magazine at the front of the machine.

Power Press with Hand-filled Magazine Feed

In the power presses which we have at present had under consideration, provision has been made for automatically loading the magazine ready for handling a subsequent operation. Figs. 17 and 19 show a different type of equipment in which larger pieces of work are handled and where the magazine must be filled by hand. Referring to these illustrations, the magazine is shown at *A*, and blanks put into it drop by gravity so that they may be caught by a transfer slide *B* which is slightly less than the thickness of the work. Transfer slide *B* receives its movements from a lever *C*, which is reciprocated by the link mechanism, clearly shown in the illustrations, that receives power from the slotted crank carried by the main shaft of the press. Connected to the transfer slide *B* there is a cam-block *D* that reciprocates with it. This cam-block is provided with grooves to receive rollers *E* that are carried at the inner ends of fingers *F* that

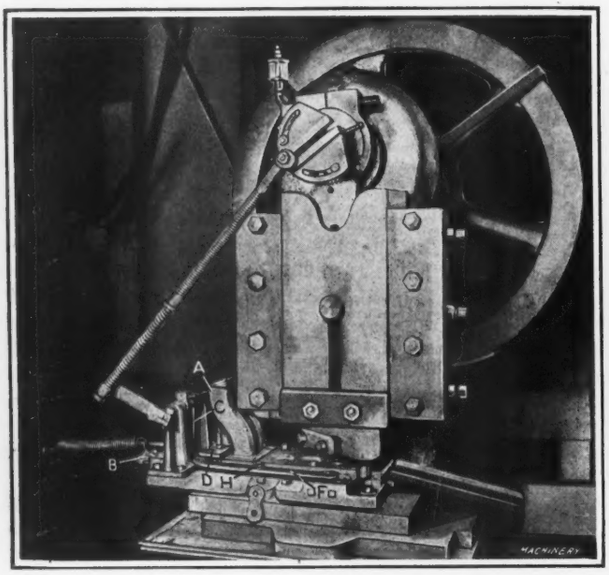


Fig. 17. Piercing Press equipped with Magazine Feed, Transfer Slide, and Automatic Chucking Device for locating Work

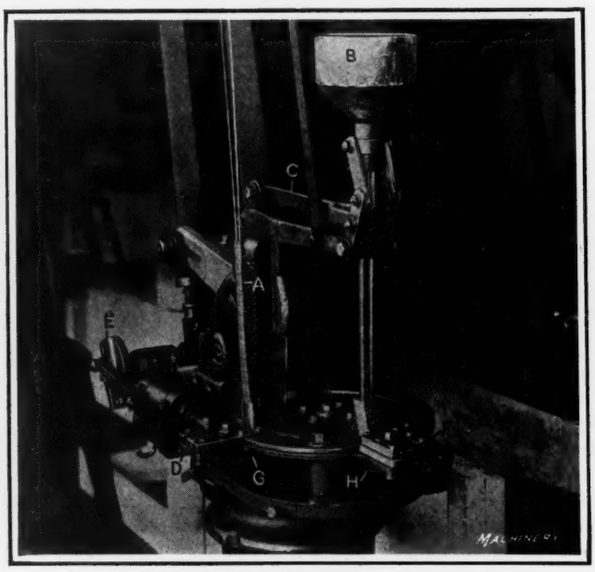


Fig. 18. Power Press equipped with Magazine for Solid Rivets, a U-wire for Pierced Blanks, and a Work-carrying Dial

actuate V-blocks *G* to locate the work under the trimming dies. As the cam-block *D* moves to the right, the rollers *E* run in contact with the outside of the grooves to cause the V-blocks *G* to be withdrawn from the work by swinging fingers *F* about their pivotal supports *H*, and as the cam-block *D* is withdrawn to the starting point, it is the inside of the grooves which engages rollers *E* to cause fingers *F* to swing about their pivotal supports in the opposite direction, thus gripping and locating the work in the desired position. It will be noticed that a row of blanks to be trimmed extends along the channel in the bed of the fixture, and after each blank has been released by the V-jaws *G*, the next forward movement of the transfer slide causes the adjacent block to the left to push this block out of the dies so that it may drop into a receiver placed in position for that purpose.

Magazine Feed Mechanism on Assembling Machine

In assembling various types of sprocket chains made by the Diamond Chain & Mfg. Co., it is necessary to press two rivets into holes at opposite ends of a piece known as a "side plate." This constitutes the first step in the process of assembling. For use in the performance of this operation a power press is employed, that is equipped with a hopper and two feed-chutes through which rivets are delivered to the holes at opposite ends of the side plate; and there is a U-wire magazine from which the side plates are fed to the machine. The power press is furnished with a dial feed with pockets around the circumference of the dial, each of which receives a side plate and two rivets, so that these parts may be carried around to the die that pushes the rivets down into the holes in the side plate. Fig. 18 shows a press equipped for the performance of such an assembling operation, and referring to this illustration it will be seen that the side plates are carried on a U-wire at *A*, and hopper *B* contains the rivets. This hopper is furnished with an agitator operated by link mechanism *C* in order to assure uniform delivery on rivets through the two chutes. These rivets drop into place in V-shaped notches in the edge of the dial, which locate them over the holes in the side plates, that are pushed into pockets located on the under side of the dial. For this reason it is necessary for the side plates as they drop off the U-wire *A* to be pushed into successive pockets on the dial. This result is accomplished by a cross-slide *D* that is actuated from a slotted crank *E* through a suitable arrangement of links and cams. A slide is also required to push the rivets forward as they drop out of the feed-chute from hopper *B* into place in the notches in the dial. The end of the slide employed for this purpose is shown at *F*, and it is actuated by an arrangement of links located under the table which supports the dial feed mechanism. Both slides *D* and *F* are returned by a positive mechanism, and their forward movement is accomplished by means of tension springs, the two springs used for this purpose being shown at *G* and *H*, respectively.

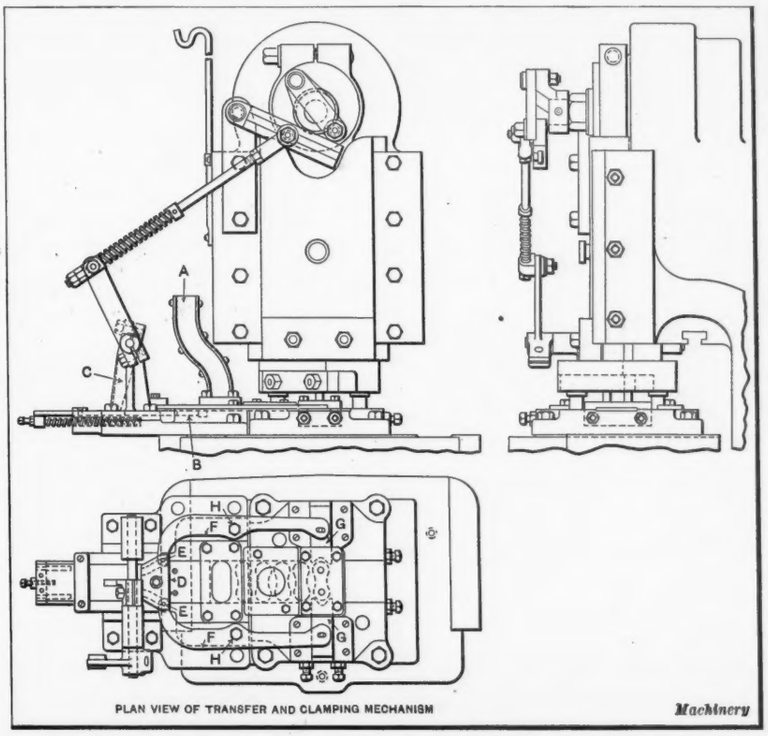


Fig. 19. Front and Side Elevations and Plan of Transfer Mechanism used on the Power Press shown in Fig. 17

Advantages of Magazine Feed Mechanisms

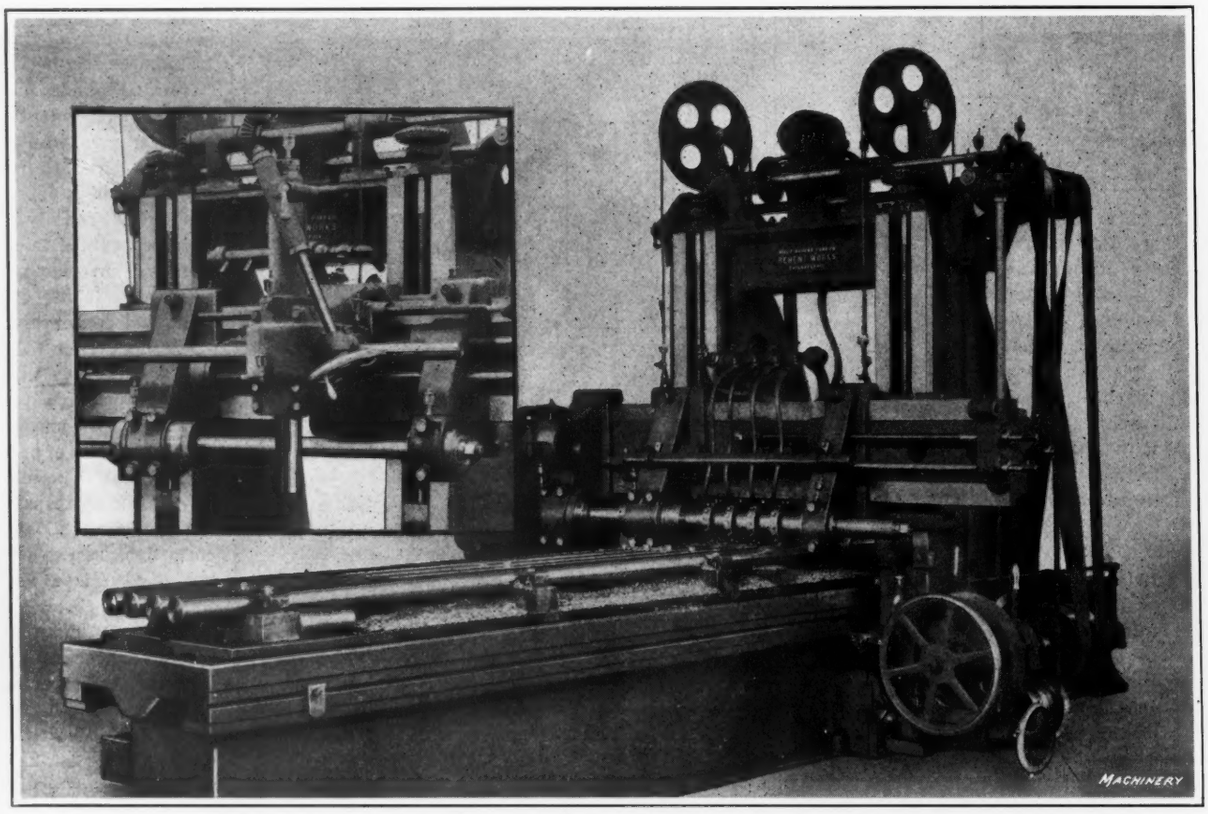
There are a number of noteworthy advantages which should commend the use of magazine feed mechanisms to the attention of manufacturers who are engaged in the quantity production of small or medium sized duplicate parts. Important among these is the fact that devices of this kind may be modified in such a way that they are well suited for handling a very great variety of work that is done by a large number of different classes of machines. In addition to this feature of adaptability, which is often a very important consideration, attention has already been drawn to the saving of idle time for both machines and their operators which is accomplished through the provision of automatic means for supplying a fresh blank directly an operation has been completed, without requiring the operator to give the machine attention each time that the piece of work on which it is engaged has been finished. There is a third factor that may assume very considerable importance during periods of great industrial activity, when the labor supply is less than the demand. It is the fact that machines equipped with these automatic feeding devices are made practically independent of the operators, who are only required to provide a fresh supply of blanks as rapidly as those contained in the hoppers become exhausted. Not only does this conserve the operators' time, and by reducing the number of operators that are needed to produce a given volume of product, make it possible to effect a corresponding reduction in labor costs against the job; but it also is a very important factor in enabling manufacturers to secure the necessary number of employes to handle their work in times when there is keen competition in the labor market. Fewer operators are required where magazine feeding devices are used, and they can be of an unskilled class and easier to find than those who have received mechanical training.

* * *

The most successful specialists are those who, after having gained a thorough general experience, devote the knowledge thus obtained to the improvement of a single type of mechanism or line of machines. Then, after having become thoroughly familiar with this product, they will be able to incorporate in their work all the experience, training, and knowledge gained from other lines. Such a specialist does not usually become narrow or one-sided. While he applies himself to a single line of thought and work, he is generally still open to new ideas, is able to see the value of improvements and can apply principles employed in other lines to the specialty to which he devotes himself. Furthermore, such a man, with a comparatively brief period of preparation, should be able to apply his mind to the solution of any problem in machine design, and to turn successfully from the problems of one specialty to those of another without having to begin at the beginning.

MILLING KEYWAYS IN LONG SHAFTS

Some shops have found it expensive to provide for cutting keyways in long shafts, where the available tool equipment does not include a machine that is well suited for handling such a job. In connection with the following description, there is shown a 36- by 36-inch by 14-foot horizontal slab milling machine built at the Bement-Miles Works of the Niles-Bement-Pond Co., 111 Broadway, New York City, for use in simultaneously cutting keyways in four long shafts. It will be apparent that four inserted-tooth cutters are provided on the arbor for milling the keyways and that a simple form of work-holding fixture is mounted on the table, which consists of cradles to support the shafts, and straps for holding them down in place. This machine was originally designed with a vertical spindle as shown in the upper left-hand corner of the illustration, to provide for using an end milling cutter for removing fillets from the ends of the keyways that are left by the curvature of the large cutters; but as the Niles Tool Works of the Niles-Bement-Pond Co., where the machine is used, do not spline any keyways except those which extend the full length of the shafts, it was considered unnecessary to provide the machine with a vertical spindle.



Niles-Bement-Pond Slab Milling Machine equipped for milling Keyways in Long Shafts—Detail View of Vertical Spindle for removing End Fillets

A carbon steel, containing from 0.30 to 0.40 per cent of carbon, is used for making the shafts on which this keyseat milling operation must be performed. These shafts are 3.686 inches in diameter by 14 feet 2 inches long, and the spline grooves to be cut are ¾ inch wide by ⅝ inch deep by 10 feet 6 inches long. The inserted-tooth milling cutters were made by the Niles Tool Works and have blades made of Rex AA steel, alternate blades having one and two chip breakers. The cutters are 8⅜ inches in diameter. They are driven at 12 revolutions per minute, corresponding to a cutting speed of 26.3 feet per minute with a feed of 2 inches per minute. The time required for setting the work-holding fixture up on the milling machine table is approximately eighty minutes, and forty minutes is occupied in setting up four shafts in the fixture; then it requires sixty-three minutes to actually cut the spline grooves.

In connection with the figures showing the speed and rate of production, attention is called to the fact that the driving motor was not equipped with a proper controller at the time these data were obtained, only one speed being available which was not ideal for the conditions of operation. It should be possible to mill this steel at a cutting speed of from 40 to 50 feet per minute, but the rate of feed could not be increased, as there is a tendency for the cutters to exert a tearing action on the work. Any increase in feed would cause a loss of time through making it necessary to subsequently finish the keyways. The shafts have double keyways cut in them, and the production figures refer to the cutting of one keyway. Approximately one hour would be needed to prepare the shafts for performing the second operation.

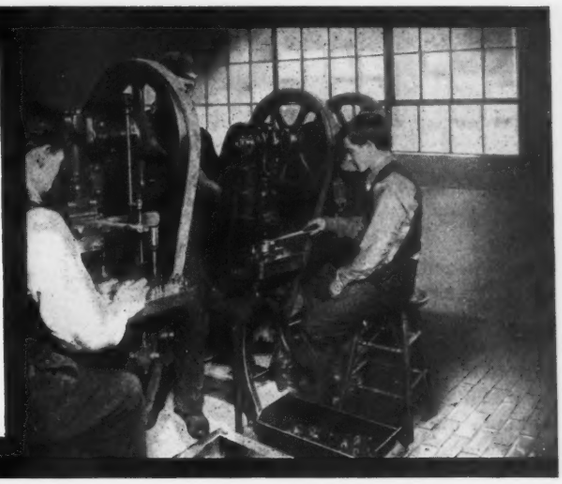
* * *

SWEDISH INDUSTRIAL STATISTICS

The Scandinavian countries, particularly Sweden, are destined to become leading industrial nations in Europe. Sweden is rich in water power, iron ore, and other minerals necessary for industrial development. In 1916, nearly 7,000,000 tons of iron ore and over 720,000 tons of pig iron were produced. Of other minerals, the manganese and zinc ores are important. The metal industry ranks first among the manufacturing industries of the country, the other important industries being wood, pulp, paper, textiles, leather, and chemicals, in the order mentioned. In 1915, there were nearly 10,000 factories in operation employing over 400,000 workers. The available hydraulic power is estimated at nearly 7,000,000 horsepower, of which in 1916 over 1,100,000 had been developed and put into operation. The increase in the foreign trade from 1910 to 1918 was 75 per cent. At present there is an active development of the abundant water power resources and a more general electrification of the railways has begun. Electric power is also being transferred by submarine cable to Denmark. It is believed that the favorable location of Sweden with reference to the principal markets of Europe, and the possession of a large merchant marine will stimulate the development of Swedish commerce and industry.

Dies for Automobile Wheel Hub

By J. BINGHAM
President, The B. J. Stamping Co., Toledo, Ohio



IN the production of a wheel hub for a small automobile, nine dies were required to complete the part. The methods pursued in the production of this hub and some of the dies employed will be described in this article. The illustrations show the dies that are to be dealt with and the appearance of the work after each successive drawing operation has been performed. Unless otherwise stated, all of the die parts are made of steel and are hardened and ground. The work was drawn from hot-rolled strip steel, 5/32 inch thick.

The first operation, which consisted of cutting the blank to a diameter of 7 inches, was performed by a blanking die of standard construction, and consequently is not illustrated. The first drawing operation on the shell was performed by the double-action type of die shown in Fig. 1, which was used in connection with a double-action press. Prior to operating, the punch *A* and the blank-holder *B* are in a raised position, with the lower face of the punch somewhat higher than the lower face of the blank-holder. The blank is placed within the gaging ring *C* and rests on the forming ring *D* and the die-block *E*. On the downward stroke of the press ram, the blank-holder descends until it comes in contact with the blank, in which position it remains and holds the blank while the punch continues to descend and draw the shell as shown. By this arrangement, pressure is applied on the blank by the blank-holder during the drawing operation. On the return stroke of the press ram, the punch is raised from the die, somewhat in advance of the blank-holder, and thus the blank-holder prevents the shell from adhering to the punch. The knock-out pad *F* is provided for ejecting the shell from the die. The punch and blank-holder are both made of cast iron.

The die illustrated in Fig. 2 is employed to make the first reduction in the diameter of the shell and to continue the formation of the flange. The shell is placed on the forming ring *A* and as punch *B* descends it is drawn to the shape illustrated. The punch is equipped with a knock-out rod which operates in the hole *C* and which forces the shell from the punch after the operation has been performed. The knock-out pad *D* is provided for ejecting the shell from the die. The punch *B* is made of cast iron. Similarly constructed dies are used to make the second, third, and fourth reductions in the diameter of the shell and to continue the development of the flange. Fig. 3 shows the shell as it appears after each of these operations. It should be noted that, in the first reducing operation, the shell was drawn to an over-all depth of 2 5/32 inches and the flange formed to a diameter of 5⅞ inches. As these dimensions are maintained during the successive reducing operations, it is obvious that as the diameter of the body is decreased, more metal is formed in the flange. It will be noted that the metal which connects the flange to the body is, in each case, formed to a large radius. By this method of gradually forming the

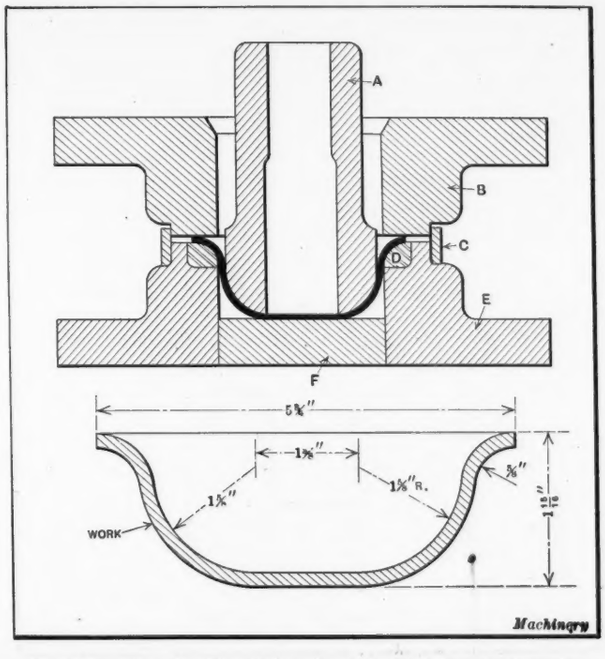


Fig. 1. Double-action Die which performs the First Drawing Operation on the Shell

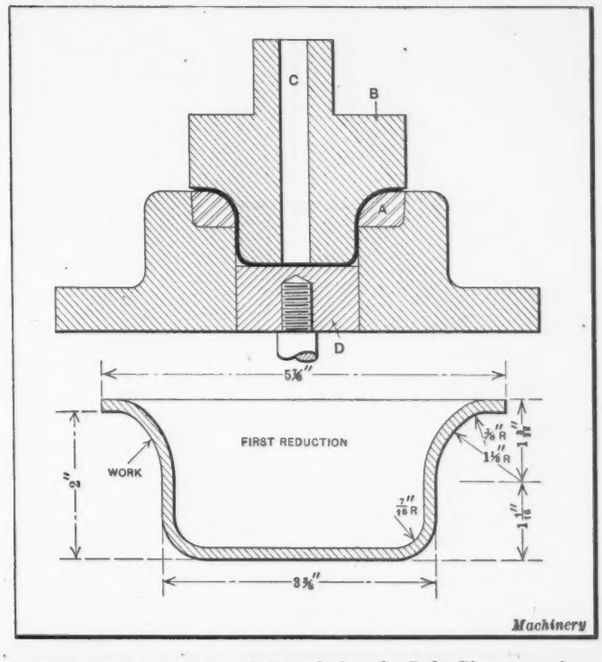


Fig. 2. Type of Die used for reducing the Body Diameter and forming the Flange

flange by several operations, comparatively large flanges can be readily produced on work of this nature.

The final drawing operation is performed by the die illustrated in Fig. 4. In this operation, part of the flange is formed to an angle of 30 degrees, a portion of the body is straightened, and the diameter of the flange is increased slightly. The next operation consists of trimming the flange to the desired diameter, for which purpose a plain blanking die is employed which is equipped with a device for locating the shell in the die properly preparatory to the operation.

The work is completed by the die shown in Fig. 5. In this operation, a hole is cut in the end of the shell and six holes are pierced through the flange. The hole is cut in the body as punch *A* passes the upper edge of cutting ring *B* on the downward stroke of the press ram. At the same time, the holes are pierced through the flange by the punches *D* as they pass the upper face of the bushings *E*. Punches *D* are held in the punch through the use of set-screws. The scrap metal resulting from punching these holes, and also the scrap from the large hole, falls through openings in the die-block into a suitable receptacle. The sleeve *G* is provided for locating the shell concentrically with the die prior to the operation. The die is equipped with stripper *H* for forcing the shell from the punches after the operation has been performed. This stripper is attached to punch-holder *J* by means of fillister-head screws. If the shell adheres to punches *D* and *A* on the return stroke of the press ram, it will cause the stripper to be raised until pusher *K* comes in contact with a knock-out bar on the machine. This is accomplished near the end of the stroke. At this point rods *L* prevent the stripper from being raised further; consequently the shell is forced from the punches by the stripper as the ram continues to ascend, which brings the shoulder on punch *A* into contact with the lower side of stripper *H*. The dies described in the foregoing were made while the writer was superintendent at the Acklin Stamping Co., Toledo, Ohio.

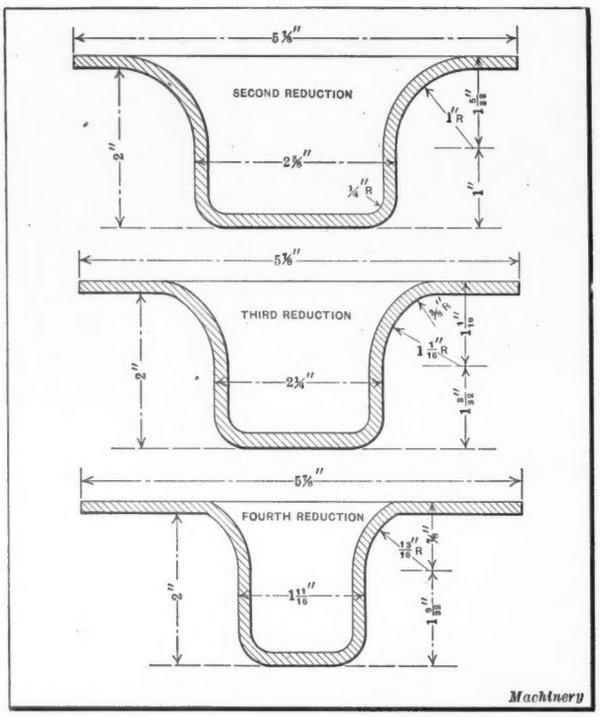


Fig. 3. Appearance of the Shell after the Second, Third, and Fourth Reductions

* * *

The Association of Railway Executives with headquarters at 61 Broadway, New York City, has published some information concerning the relation of railway freight rates to the increased cost of living, pointing out that freight rates have played a very small part in the rising cost of living. The fact that the waste of war, under-production, and other causes have added dollars to the cost of necessities of life while freight charges have added only cents is emphasized. For example, a suit of clothes that sold at $30 was carried before the war from Chicago to California for 16½ cents; today the railroads charge 22 cents for carrying the same suit to California, but the suit sells for $50. In other words, the cost of the suit has increased $20 while the freight has increased only 5½ cents. In the same way, the $5 pair of shoes that now costs $10 is carried from the New England factory to the Florida dealer for less than 6 cents at the present time, and this is only 1 cent more than the freight rate before the war.

* * *

The depression in the European industries is strikingly indicated by the condition of the Swedish iron industry. The export of pig iron from Sweden during 1919 was less than half the exports during 1918, and the same holds true of the exports of finished iron and steel.

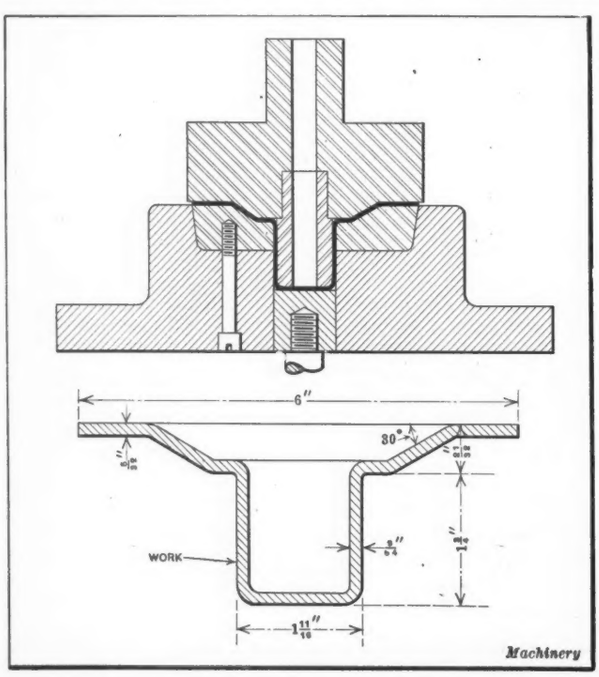


Fig. 4. Die which performs the Final Drawing Operation

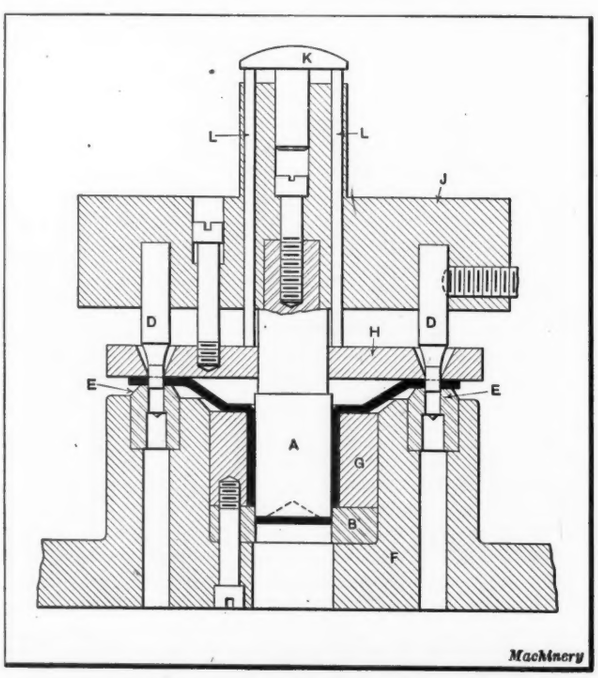
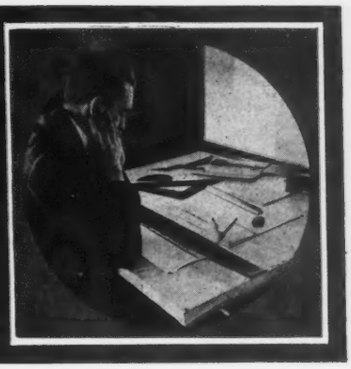


Fig. 5. Die which cuts Holes in the Flange and Body

Indicating and Recording Changes on Drawings



Description of a Method by which Alterations on Drawings may be Definitely Recorded for Future Reference

By FRED R. DANIELS

THE system used by a large machine manufacturer in recording changes on drawings is described in this article. In the manufacture of machinery on which many parts are employed, especially if such parts are subject to frequent changes, owing to minor improvements from time to time, the system will furnish a ready means of discovering the history of a changed piece. The exact state of the part at the time preceding any particular change can be readily determined, so that when entering repair orders or in ordering parts for special attachments to be applied to machines of older models, no guesswork or assumption need be resorted to in this connection. This is accomplished by consulting a card file to obtain the date of the change, and then inspecting the blueprint made on that date showing the desired change, as well as the blueprint of the previous date showing the part before being changed. A complete set of blueprints showing every change (except the most insignificant ones) that has occurred on each detail on a drawing is kept on file in suitable fireproof cabinets. These prints are so filed that they are readily accessible for inspection and are chronologically arranged by the drawing number so as to facilitate locating the desired blueprint. This arrangement will be more fully described in a later paragraph.

Simple Equipment Required in the System

Very little special equipment is employed in this system. The rubber change stamp shown on the drawings reproduced in Figs. 3 and 4, is placed on every new drawing at the time of its completion, whether it contains one detail or several, and regardless of whether or not changes are liable to occur. Frequently changes are not required, but as this is never known at the time the drawing is made, the stamp is always used, being located on the drawing, if possible, about as shown in the illustrations. Besides recording changes, the stamp is also used for each subsequent addition of a detail to the sheet or for each transfer of a detail from one sheet to another; in short, it is the indicator of all work performed on the drawing. In connection with the change stamp, a drawing change slip (thin paper) is made out by the draftsman at the time the change is made. This change slip is shown in Fig. 1. A carbon copy of the wording on the change slip is made on what is known as a change card. A change card, recording changes Nos. 4 and 5 on the drawing shown in Fig. 4 is reproduced in Fig. 2.

After making a change, the first step is to indicate it on the detail as illustrated in Fig. 4. In this instance, six changes have been made on the drawing at various times, the illustration showing just how the changes are indicated. A small circle, not more than 3/16 inch in diameter, enclosing the number of the change, with a leader pointing to the change, is placed on the drawing as shown. A similar circle and number are placed in the first space on the change stamp, together with the part number, the draftsman's initials, and the date of the change. A small spur from this circle pointing in the direction of the change assists the eye in detecting the location, which otherwise might not be readily discovered. After this has been done, the thin paper change slip and the carbon copy on the card are carefully made out.

The general wording of the change slip (and card) for change No. 1, would be as shown in Fig. 1. A circle, change number, and spur also appear on the slip and card corresponding to those on the drawing itself. This circle and spur on the slip and card may be useful as a check for the change stamp entry, and in case the latter becomes obliterated or does not properly indicate the change, its appearance on the card (which is filed in the drawing-room) will readily establish the facts. It is quite improbable that a draftsman would err in locating the circles on the drawing and then carry the error along when making out the change slip and card. The drawing number, the date of the change, the number of the changed part, the authority for making the change, and the initials of the draftsman are placed at the head of the change

DRAWING CHANGED: A-397		DATE: Nov. 19, '18	
PART NO: H-47	PER: W.H.D.	BY: E.D.	
① Changed Extension Arm H-47 by increasing size of hole from 0.875" to 0.880" to accomodate change in stud used.			
PATTERN: No		ORDER DEPT: ✓	
PERMANENT FILE: yes		COST DEPT: ✓	

Fig. 1. Drawing Change Slip, which is made out by Draftsman when changing Drawings

DRAWING CHANGED: A-397		DATE: July 14, '19	
PART NO: H-47	PER: M.E.F.	BY: E.D.	
④ Changed Extension Arm H-47 by counterboring 3/4" drilled hole, 1" diameter and 1/8" deep to allow assembly of headed stud as per change in design.			
⑤ Changed Extension Arm H-47 by finishing hub to 0.748" by straddle milling, as per complaint by assembling Department			
PATTERN: No		CHECKED BY: W.H.P.	
PERMANENT FILE: yes		DATE: 11-25-18	

Fig. 2. Drawing Change Card, which is finally filed in Drafting-room Card Index File

slip, and duplicated on the change card as shown, the slip and card then being attached to the drawing which has been changed, and sent to the checker.

Use of Change Record in Checking and for Assignment of Shop Blueprints

The information contained on the change card (Fig. 2) indicates to the checker immediately the location of the change and by whose authority the change was made. Then by securing the correspondence, or the order for the change, from the manuscript file, he can readily determine whether the changes have been made in accordance with instructions. After the drawing has been properly checked both in regard to the actual change and to see whether or not it agrees with the requirements, the checker is required to sign and date the card in the spaces indicated in the lower right-hand corner.

From the checker the drawings pass to the man in charge

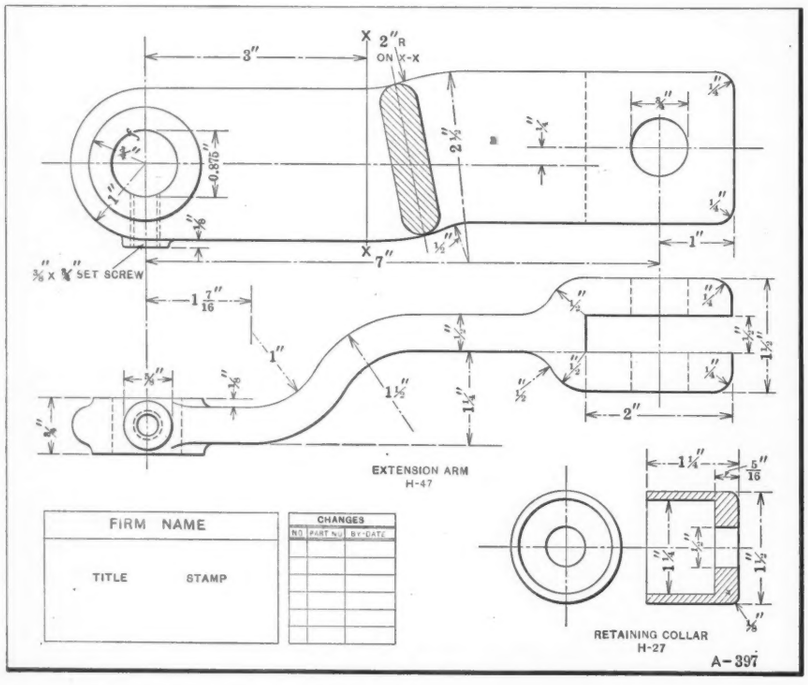


Fig. 3. Detail Drawing before being changed, showing General Arrangement and Location of Change Stamp

of sending the blueprints to the shop departments. He first investigates the change, considers its effect upon the pattern work, machine work, etc., and sends blueprints to those departments which will be directly affected. Whether or not the change affects the pattern work is indicated by him in the space provided on the card and slip, and a blueprint is sent to the pattern shop if necessary. If the change is of a minor character he will not send a print to the fireproof file, previously referred to, but in all other cases, a print is made for these files. In either event, he indicates the fact on both card and slip. He also removes the card and slip from the drawing before it is sent to the blueprinting department. This assignment of blueprints is made the first thing every morning, and the drawings, when sent to the blueprinting department, are accompanied by suitable instructions as to the number of prints to be made and also the department numbers to which they are to be sent. After the cards and slips have been removed from the drawing, the former are used by the clerk in charge of the drafting-room records to aid in making changes that may be necessary in the drafting-room files. The cards are then filed in chronological order in the drafting-room, and constitute a permanent reference file. After the cards have accumulated to the maximum capacity of the file, the older cards should be removed and preserved indefinitely in an auxiliary file or box.

How the Change Slips Affect Records of the Order Department and Cost Department

The change slips are first sent to the order department. This department has charge of preparing lists of parts required for all orders, and in conjunction with maintaining these records the slips are referred to as a means of detecting any change which will affect directly or indirectly the order sheet or list of parts. From this department investigation is carried on in the shop to ascertain whether the required change on the piece has actually been made in accordance with the drawing change. It is in regard to those changes which affect the machining operations rather than the design that the order department is chiefly concerned. The reason for this is, of course, that many changes occur such as No. 1 or No. 3, Fig. 4, and it is evident that changes of this nature affect directly the size of the studs or shafts on which these parts are assembled, and indirectly, in many instances, a great many other parts, so that it becomes necessary to change the order accordingly.

After the slip has been used to revise the orders in the order department, it is checked as shown in the lower right-hand corner of Fig. 1 and sent to the cost department. The cost department is also vitally concerned in the machining operations as affected by the change. In the manufacturing plant in which this system was employed, a piece-work system is used; consequently it will at once be evident that changes which affect machining operations must necessarily result in a readjustment of the piece ratings, not only for the actual machining but also for assembling, trucking, etc. It is the duty of the cost department to investigate the change and to make the proper rate changes to agree with the additional or reduced time consumption. In most cases, changes in machining operations will affect the jigs and fixtures, and the additional expense incurred must, of course, be taken into consideration when rearranging the cost accounts. The receipt of the slip by the cost department is also acknowledged by a check mark as shown. These slips are finally filed in this department.

Examples Illustrating the Practical Value of the System

When a new part is added to a drawing, the procedure is not different from that followed when changes in detail are made. If the detail H-27, Fig. 3, had been added or transferred to the sheet after the drawing had originally been made, an index circle and spur pointing to the pattern number would be entered in the stamp just as though a change had occurred. There is a date in the title data stamp which indicates the date on which the drawing was made. All other subsequent additions can be readily traced by means of this date and the date opposite the circle indicating the addition. Fig. 3, however, shows the drawing as it would appear when the two details are simultaneously drawn. The first change (see Fig. 4) occurs on the extension arm H-47 and consists of changing the size of the hole from 0.875 to 0.880 inch to accommodate a change in the diameter of the stud employed. Of course, the reason for changing the stud would be stated on the change card which accompanies the drawing of the stud. The change slip and card for this change would be worded about as shown in Fig. 1, and should be complete enough to furnish all information that would be required in looking up the change. However, if this does not satisfy the requirements, the correspondence connected with the change may be readily found in the manuscript file entered under the name of the part changed or under some

other heading which will readily identify it. In this case the authority is W. H. G., these being the initials of the man from whom the change order was originally received.

If often happens that the nature of the change is such that it affects the pattern work, particularly in the case of interferences in the operation of the machine. Change No. 2, Fig. 4, consists of adding a reinforcing rib for additional strength, and of course, this affects the pattern work, but it would not ordinarily change the method of molding. It is frequently necessary to throw away old castings of changed patterns which may be in storage. The determination of this question is the prerogative of the chief draftsman, and decision is arrived at after consultation with the foreman of the pattern shop. If, however, it is possible to use the pieces at some future time on orders of an early model, for instance, these parts will be retained in storage and the records properly changed to indicate this fact. In the case of change No. 2, however, it would be unwise to keep the castings in storage, because this change was made to assure additional strength. Therefore those castings without the rib would obviously be too weak and not suitable for use. When the change in the pattern affects the process of molding, the method of handling the change is directed by the foreman of the pattern shop.

In rare cases the change is such as to necessitate an entirely new pattern on account of the molding proposition. This contingency, however, is always guarded against in the drafting-room. Change No. 3 also affects the size of a hole, but in this case the hole was previously not finished, so this change constitutes establishing a new machining operation. This is a matter to be taken care of by the cost department, and necessitates the making of a jig or some form of holding arrangement.

Further Examples of Recording Changes

It will be seen that the dates of changes No. 4 and No. 5 are concurrent but that a different change number is used for each change. This eliminates the possibility of overlooking the fact that two changes were made at the same time, which would be liable to occur if only one change circle and two spurs were employed. Fig. 2 shows the change card as made out for these two changes. As in the previous instance for change No. 1, the wording is such as to furnish adequate information when investigating the exigency for making the change (as the order department in entering repair orders is frequently required to do). This investigation may bring to light the fact, for instance, that a certain change was made in order to facilitate assembling. Facilitating assembly does not usually entail an appreciable amount of saving, except where large quantities of parts are involved; therefore the extra amount of energy required to assemble the unchanged part on the repair order is negligible. The storage records may show that there are a few unchanged castings of this pattern in stock. The repair order man's problem is then immediately solved and the unchanged part is sent on the order, which results in a considerable saving in time and labor.

Change No. 4 consists of counterboring the ¾-inch diameter hole to a diameter of 1 inch, ⅛ inch deep. The blueprints for this change would, of course, be sent to the drilling department. Change No. 5 is an entirely new operation because the piece was not formerly finished on the hub. This change demands that a blueprint be sent to the milling department and a new piece rating must be established. Change No. 6 illustrates the procedure when a change is made upon a change, which sometimes occurs. It will be noted that the indicating circle for the No. 3 change remains as formerly, and in connection with the corresponding change card will tell the story quite clearly. This change is simply an increase in the size of the finished hole from 0.505 to 0.567 inch.

Contrary to what might be believed, the appearance of these circles and pointers does not confuse the reading of the drawing but, on the other hand, they stand out prominently as distinct, separate indicators. It rarely occurs that more than one change stamp is required on a drawing. Sometimes this does happen, however, and sufficient allowance should be made by the detailer in arranging a drawing to permit the use of an additional stamp if necessary. If the change in the piece is quite radical it may be advisable to redraw and rearrange the drawing. In this case the old sheet is preserved and filed in a separate cabinet. This enables the redrawn sheet to start anew with no changes

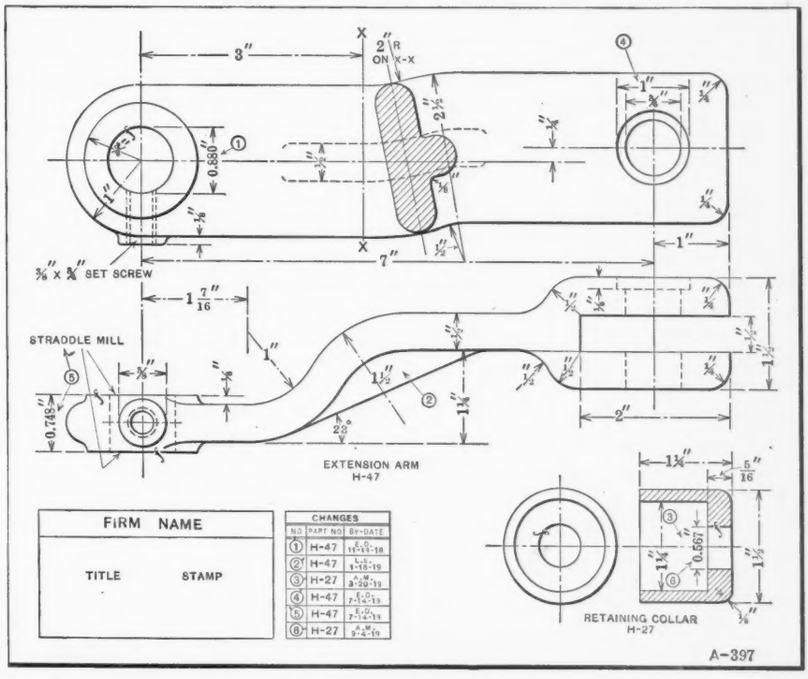


Fig. 4. Appearance of Drawing shown in Fig. 3, after a Series of Changes has been made on the Details

appearing on it, but as an indication that the sheet has been redrawn, a note stating that fact with the date of the redrawn sheet is entered at the lower margin of the new drawing. The new date in the title data stamp will furnish the date of redrawal.

How the System is Utilized by the Order Department when Entering Repair Orders

The cabinet files previously referred to in which the blueprint of every change is preserved as a permanent record are for general use and are very carefully maintained. The order department, in handling orders for repair parts or for separate attachments, can readily find the blueprint of the desired date by consulting these files. It often happens that ten or a dozen, or even more blueprints of the same number of various dates are filed in this cabinet. Thus, in the case of drawing A-397, Fig. 4, there would be six prints, one for the original drawing and five for the five dates on which the six changes were made.

As an illustration of the value of this system to the order department on repair work, let it be assumed that on September 29, 1919, an order was received for the retaining collar H-27 for repairs. The man handling this particular job would first obtain from his records the entry date of the original order for which the desired repairs are required. The repair part must conform in every important detail to

the design of the part on the entry date, which, for example, may be December 6, 1918. If it is discovered that changes have been made and if the order department records do not furnish sufficient information to establish beyond all doubt the nature of the change, the first step would be to consult the change card in the drawing-room card file. Evidently the order department records show that changes have been made on the part on March 20 and September 4, 1919. In the card file a number of cards for both these dates may be found, but it is only a matter of a moment to select the desired cards from which it would be found that on March 20, 1919, a change had been made on the hole, and that on September 4, another change had occurred on the hole. The wording on the cards should be such as to furnish all the information that would be desired. Since the date of the original order (December 6, 1918) for which the repair is required is prior to that of either change, the fact has been established that those finished parts now in storage cannot be used on this order. The next step would probably consist of determining from the storage record whether or not any parts of No. 3 change are carried in the storage bins, for it is obvious that such parts can be used on this order since the hole was then merely changed from ½ inch to 0.505 inch diameter.

If the change cards do not furnish complete information the permanent blueprint file may be resorted to, in which, under the proper date, a blueprint for each change will be found, indicating the exact nature of that change and the appearance of the piece before it was changed. It is evident that this method is especially valuable in the case of repair parts which are so old that no authentic records of them have been made. For such parts it is assumed that the piece to be sent on repairs would be so described that identification could readily be made; if not, a rough sketch of the part or the broken or worn casting itself is usually required.

In connection with making changes, it may be well to mention a fact which is of considerable importance when making erasures on drawings. The original drawing of the extension arm H-47, Fig. 3, shows a section through the offset curve. This perhaps was necessary to avoid making an additional view, or perhaps the proper space for making a separate section was not allowed. In any event, the addition of the rib, change No. 2, Fig. 4, would ordinarily require that a separate view be drawn. However, by drawing in the web and changing the section as shown, the necessity of making a new drawing at this time is eliminated and the drawing work greatly reduced. Should this sheet ever be redrawn, a general rearrangement in this regard would probably be made at that time.

* * *

SCIENTIFIC MANAGEMENT AND LABOR

The *Bulletin of the Taylor Society* calls attention to the almost incomprehensible opposition on the part of the American Federation of Labor to scientific management. Doubtless this opposition is due to a misunderstanding of the aims and objects of this method of management. Organized labor, it seems, is inspired by fear that the differential rate system would impair one of the fundamental principles of the labor unions—the union rate. The management of the American Federation of Labor also appears to have accepted certain opinions held by a great many workers, such as, that increased output will cause unemployment and other erroneous ideas concerning the operation of scientific management, which do not conform to facts. As a matter of fact, scientific management is nothing but a method whereby everyone's labor is made to count for more than it did formerly, and as each individual's labor becomes more productive, his earnings are also increased. Neither organized nor unorganized labor can possibly suffer from a proper application of scientific management. On the contrary, the earnings of all will increase, because earnings depend upon quantity of production. Furthermore, this is the only way in which prices will ever be reduced.

A MACHINE TOOL BUILDER'S OBSERVATIONS OF PRESENT EUROPEAN CONDITIONS

Commenting upon the conditions abroad, Charles D. Oesterlein of the Oesterlein Machine Co., Cincinnati, Ohio, who recently returned from Europe, calls attention to the difficulties under which the industries in Europe generally are working at the present time. Germany particularly is in a difficult position due to the lack of means of transportation, as it has not yet been able to replace the rolling stock that under the armistice conditions had to be turned over to France. It seemed to Mr. Oesterlein that about one-fourth of all passenger and freight cars in France were formerly German, as indicated by the double eagle which had only a white cross painted through it. Germany is also turning the surplus stocks of all kinds of materials and goods into cash at a great sacrifice in order to close a deal. This is particularly true of machine tools. Last fall, for example, there was an entire shipload of machine tools forwarded to Italy, two-thirds of which were unloaded in Genoa and the other one-third at Naples. One German firm has already opened offices in Milan and others have commercial travelers doing business in Italy. In a large meadow near Delft in Holland, thousands of machine tools were unloaded in the open and prospective buyers were asked to name their own price for them. It would appear that the reason for the selling off of German machines and goods in this manner is mainly because of the critical shortage of food, coal, and other raw materials, making it necessary to sell whatever can be sold to be able to buy some of these necessities. Austria and Poland seem to be in a still worse condition and the industrial situation in Italy is not much better. With the exchange situation as it is at present, the conditions seem quite grave.

All this has a bearing upon foreign machine tool trade. Imitations of American machines are frequently seen especially in the neutral countries where the machine tool industry was largely developed during the war. Mr. Oesterlein mentions having seen a cylindrical grinding machine of exactly the same type as the No. 8 Brown & Sharpe machine and asked what firm was making this machine. The answer was that in Sweden alone, eleven different firms imitated this machine. Four copies of an American milling machine were also seen. In Switzerland, where before the war there were only a handful of machine tool builders, of which only one was important, there are now approximately 150, this statement being based upon statistics published there. Mr. Oesterlein was surprised to see imitations of his own milling machine built in Christiania, Norway. In a similar way other industries have been developed in most of the neutral countries because during the war they were unable to obtain the products required from the former sources of supply. Mr. Oesterlein concludes by stating that American machine tool builders before making extensions to present plants to take care of immediate domestic business, should give thorough consideration to the European situation and the question as to how much foreign trade will be available in the future.

* * *

National Safety Council, 163 N. Michigan Ave., Chicago, Ill., requests manufacturers to make use of the Safety Council's library, which is a working reference library specializing in safety literature. A small booklet has been published describing this library and information bureau, calling attention to how safety engineers may make use of the library to the best advantage. It is pointed out that the library of the National Safety Council is a service bureau for all interested in safety literature, and that the library is always glad to give assistance freely. The council has also increased the scope of its activities along other lines by the publication of a weekly news-letter called the *National Safety News*, and by the preparation of posters emphasizing the need of care and thought in order to avoid accidents.

TRAINING FOREMEN IN EFFICIENCY METHODS

The Warner Gear Co. of Muncie, Ind., has inaugurated a plan of training for their foremen and other members of the supervisory force which is of considerable interest. A class of one hundred men has been formed to pursue a course in modern production methods, which comprises the study of specially prepared text material, the solution of practical factory problems, and the discussion of this material at six bi-weekly meetings held in the plant after hours. These meetings are providing an opportunity to bring home the application of the work to the special production problems of the company. At each meeting a lecture is delivered by an experienced production man, which is followed by a round-table discussion. Included in the group, besides foremen, are the chief plant executives, which insures that the policies of the management will be correctly interpreted to the members of the class. The subjects covered in the training are: (1) How to promote teamwork in the shop; (2) handling workers by methods that make for harmony and efficiency; (3) improved methods of factory organization; (4) handling materials and equipment productively; (5) reducing costs and stopping leaks; and (6) modern ideas of management. The course is conducted under the direction of the Business Training Corporation of New York, who supply the text material and the instruction service. The lectures are also given by the staff of the Business Training Corporation. The course is not technical but deals in basic facts and principles.

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SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held at St. Louis, Mo., May 24 to 27, with headquarters at the Hotel Statler. In view of the interest throughout the Mississippi Valley and in the territory contributory to it, one session will be devoted to a discussion of river-transportation problems, and the movement now under way for the development of transportation on the Mississippi River, with New Orleans as the port for shipment of goods to South American and other countries. Another session will be devoted to the subject of the valuation and appraisal of industrial properties, using as material the papers presented at the last annual meeting, upon which discussion is being solicited by the Committee on Meetings and Program. Papers are also in prospect on fuels, oil engines, measurement of the flow of water, transmission of heat, pumping engine tests, airplane design, etc. A paper is to be presented by the recently elected honorary member of the society, A. C. E. Rateau, of France, on "Turbo-compressors for Increasing the Power of Airplanes at High Altitudes." It is also expected that papers will be presented by the Mid-Continent Section, representing the oil districts of Oklahoma, on subjects relating to the distribution and use of oil for industrial purposes. In addition many papers of general engineering and industrial interest will be presented.

MEETING THE INDUSTRIAL DEMAND FOR TECHNICAL MEN

Realizing that technical schools are not serving the industries to a maximum degree, the Technology Clubs Associated have called a meeting at Drexel Institute in Philadelphia for March 25 to 27, at which plans will be discussed for more adequately meeting the industrial demand for engineers. The president, Dr. Hollis Godfrey, who was chairman of the engineering education section of the Council of National Defense during the period of the war, foresaw an alarming shortage of trained men. He saw that there was much waste in present technical education and that to eliminate this waste the requirements of industry for the engineer must be specified exactly. The following plan therefore was formulated: Educators, who were also engineers, were sent out into the industry to make a study of manufacturing processes and determine what knowledge was essential if men were to be successful in the various fields. These men called conferences of executives and obtained facts from them regarding training. They attended foremen's shop meetings and talked with operators at their machines. Every possible effort was made to determine the industrial demand upon the educational institution. The findings thus obtained, together with the suggestion of the representative plants visited, were submitted to a board of educational experts, who outlined courses and formulated plans to meet the demand with the possible educational supply. At the meeting of the Technology Clubs Associated there will be gathered representatives of educational institutions and of industry, and a composite plan for future education will be worked out. The results of the preliminary studies and of the meeting will be put into a permanent record in book form.

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A COMPARISON OF EXCHANGE RATES

In a recent issue of *The Nation's Business*, published by the United States Chamber of Commerce, a comparison is made of exchange rates at various intervals from July, 1913, to December, 1919, under the heading "What Does a Dollar Cost Abroad?" In giving the present value of the dollar abroad, a comparison is made with the normal exchange rate or the average exchange rate previous to the war. It is of the greatest importance to the American manufacturer who finds his foreign trade curtailed, to take note of the present conditions abroad in regard to the exchange rates. It is interesting to see, for example, that trade with Spain, Holland, and Japan is not appreciably influenced by abnormal exchange rates either one way or the other; whereas, trade with France, Belgium, Italy, and Germany is facing extremely unfavorable conditions at present.

As a comparison, the following figures giving the relative value of the dollar apply to the exchange rates February 10 of this year: England, 1.45; France, 2.80; Belgium, 2.70; Italy, 3.60; Switzerland, 1.16; Spain, 1.10; Denmark, 1.82; Norway, 1.54; Sweden, 1.44; Holland, 1.06; Germany 23.0; Japan, 0.98.

VALUE OF THE DOLLAR FROM 1913 TO 1919

Countries	July 1913	July 1914	July 1915	July 1916	July 1917	July 1918	May 1919	June 1919	July 1919	August 1919	Sept. 1919	Oct. 1919	Nov. 1919	Dec. 1919
England	$0.998	$0.997	$1.019	$1.021	$1.021	$1.021	$1.021	$1.049	$1.059	$1.115	$1.160	$1.160	$1.167	$1.215
France	1.000	0.995	1.094	1.139	1.109	1.099	1.169	1.206	1.248	1.401	1.571	1.650	1.700	1.897
Belgium	1.006	1.001	.....	.....	.....	.....	1.223	1.254	1.289	1.457	1.605	1.644	1.605	1.814
Italy	1.024	0.996	1.187	1.229	1.395	1.698	1.439	1.524	1.534	1.659	1.864	1.876	2.084	2.379
Switzerland .	1.001	0.996	1.039	1.031	0.922	0.764	0.951	0.994	1.041	1.071	1.090	1.077	1.077	1.057
Spain	1.076	1.075	0.965	0.955	0.834	0.696	0.947	0.960	0.973	1.006	1.009	1.007	0.998	0.975
Denmark ...	1.002	0.999	1.017	0.924	0.926	0.859	1.072	1.133	1.136	1.210	1.239	1.239	1.255	1.330
Norway	.....	.....	1.001	0.919	0.919	0.846	1.038	1.061	1.072	1.130	1.165	1.155	1.178	1.246
Sweden	.....	.....	1.001	0.918	0.884	0.755	1.002	1.047	1.041	1.076	1.100	1.094	1.121	1.196
Holland	1.002	0.999	1.005	0.968	0.974	0.796	0.995	1.024	1.031	1.061	1.079	1.068	1.057	1.054
Germany	1.000	1.000	1.159	1.304	.....	.....	.....	.....	.....	3.967	5.471	5.447	7.329	10.136
Japan	0.999	0.999	1.009	0.987	0.972	0.940	0.968	0.963	0.977	0.977	0.987	0.984	0.984	0.989

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THE ERA OF THE AUTOMATIC MACHINE

Since the automatic screw machine was first conceived by the pioneer machine tool builders of New England, its development has been continuous, until today it is an indispensable machine tool in many lines of work. Yet we are only at the beginning of the real era of the automatic machine. The war did more than any other factor to necessitate its use, for previous to that, while automatics were coming into more and more general use in America, most of the European countries were restricted users of these machines on account of their lower labor costs.

Now that labor all over the world is demanding higher wages and shorter hours, production cannot be maintained except by the ever-increasing use of automatic machinery in the manufacturing industries, so that quantity output may be maintained in spite of shorter hours.

The designer of automatic machinery encounters numerous interesting problems, for in no other class of machinery is there a greater opportunity to introduce ingenious mechanisms and carefully thought out mechanical movements. "Magazine Feed Mechanisms"—the leading article in this number of MACHINERY—deals with one of the many phases of this problem, and the mechanisms therein described are selected from automatic machines taken from an industry where machines of this type had been developed to, perhaps, as great a degree of perfection as in any other mechanical industry—except the manufacture of watches. The mechanisms described are employed in machines used in the making of driving chain, a product which must be produced both accurately and cheaply. The examples show some of the many ingenious devices developed in one branch of automatic machine design.

* * *

TRADE WILL FOLLOW EDUCATION

That trade follows the flag was the old idea by which enterprising statesmen justified themselves in extending, by whatever methods, the colonial possessions of their nations. But the real statesman of the new era—the man who today extends the power and influence of his nation abroad—is the business man who engages in international trade. He has invented a new maxim—*Trade Follows Education.* Instead of colonizing in distant parts of the world, he has found that the surest way to obtain the trade of foreign peoples is to educate them in regard to the use and the quality of the things he wants to sell them and to win their confidence by fair methods and square dealing.

On page 616, Julean Arnold, American commercial attaché at Peking, China, who speaks from an experience of eighteen years in the celestial empire—now the celestial republic—points out that the most certain way in which the American machine-building industries can obtain Chinese trade is by educating Chinese engineering students to appreciate the practical usefulness and superior merits of American machinery. The British maintain an engineering college at Hongkong, and previous to the war the Germans had a similar college at Shanghai. Mr. Arnold makes it clear that by so doing those countries were able to greatly further their trade with China.

America maintains no great engineering college in the Far East, but one well-known American machine tool manufacturer, realizing the importance of general educational facilities maintained by America, has individually endowed such institutions under the auspices of the Young Men's Christian Association. If one man alone can accomplish so much, what could not be done for the future of American trade in China, with its great potential markets, if American manufacturers as a whole would endow a really worthwhile engineering school in that country, preferably at Shanghai. Here Chinese students in engineering would be made familiar with American machinery, American manufacturing methods and American ways of doing business, and as these men later would be the leaders in Chinese industries, it is easy to understand how, through educational facilities, a closer relationship would be created between the two nations.

This question should be earnestly considered by the large associations of manufacturers and by the Chamber of Commerce of the United States. China is the greatest of the less developed but highly potential markets at the present time. The large European nations have their eyes fixed on the Chinese market and are using every means to obtain the future trade of the country. Americans have the advantage of being regarded with a more friendly feeling in China than any other nation. Why not cement that friendship by some definite constructive work that will not only advance the cause of practical engineering education in China on American lines, but will also build up a closer trade relationship between the two nations? Mr. Arnold, the commercial attaché of the American Government at Peking, is in a position to give complete and detailed information upon the subject to any manufacturer or association that wishes to take active steps in this connection.

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INCREASED EFFICIENCY A RESULT OF THE STEEL STRIKE

An interesting result of the steel workers' strike is reported by steel companies operating in Mahoning Valley, Ohio. It appears that in steel mills in this district there has been a noticeable improvement in the efficiency of labor as a result of the strike. During and after the strike many new men came into the mills who rapidly learned the trade, and as they started without preconceived ideas as to the amount of work they should perform in a day, their efficiency in many cases is greater than that of the old employes. In the past, it is said, many of the men restricted their production to a certain definite amount; and not only did they limit their own output but they also discouraged others, particularly new men, from setting a better pace. If the strike has aided in correcting this condition and if greater efficiency, larger production and better quality is the result, the new men have struck the keynote; for it is only through increased production that higher wages can be paid.

Recent Impressions of Industrial Conditions in Europe

By CARL F. DIETZ, Vice-president and General Sales Manager, Norton Co., Worcester, Mass.

Having just returned from Europe after a four months' stay, Mr. Dietz's observations on the European industrial conditions will prove of interest and value to American manufacturers. During his visit to Europe, Mr. Dietz had an opportunity to obtain first-hand information on the situation in England, France, Belgium, Holland, and Germany, and in view of the increasing difficulties with the foreign trade, due to the abnormal exchange rates, an accurate statement of present conditions, which have changed materially in the last few months, is indispensable.

EUROPE is in at least as great a chaotic state economically if not greater than that indicated by the picture that we have obtained through the medium of the press. Because of the marked difference in the industrial situation in the various European countries, any attempt to generalize would be futile. Much of the information published in the daily newspapers appears to be based upon rather superficial observations, or incomplete information, and should generally be accepted with caution. This is particularly true of some of the statements that have been made with regard to Germany—as exemplified by the claim that German workmen have volunteered to give an extra hour or two gratis, or to work twelve hours a day, to help in quickly rehabilitating the German industries. Not one instance of this was observed during my stay in Germany, nor did I hear of any such condition existing there in any part of the country. This is merely mentioned to indicate the unreliability of the stories circulating in the daily press. In the following paragraphs the general conditions in England, France, Belgium, Holland, and Germany will be briefly reviewed as they existed about January 1. No important change has taken place since then in any of the countries visited.

Industrial Situation in Great Britain

In Great Britain there is a very strong effort, already productive of visible results, to revive and expand the prewar industries and to create new ones. In every field where there are large markets, domestic or foreign, industries are being established on an extensive basis, and the principle of mass production is being developed in the same manner as in the United States. This is especially apparent in the automobile, truck, machine tool, and small tool fields. There is a marked tendency toward industrial consolidation, and the bringing together of coordinated industries under group management, thereby utilizing the best industrial executive brain capacity of Great Britain in the most effective manner, and under a broad comprehensive plan. The well-known machine tool building combination is one example of this, and a still more significant one is the large consolidation of steel-making and machine-building plants for the production of automobiles. The aggressive policy that England will develop is apparent in the manner in which her machine tool industry is planning to extend its trade in all the European countries as well as beyond Europe; the entry of England into the American machine tool market has already begun and will doubtless be pushed still more vigorously.

Improvement in British Labor Situation

Probably the most important phase in the British situation is the improvement in labor conditions. The serious disputes of last fall, when the railroad workers, the coal miners, and the molders went on strike, have been settled, and a more stable condition has been reached. There still are, and will be, strikes to contend with in various industries, but these are not likely to be of national character or importance as were those already settled. There appears to be a more general appreciation than last year, on the part of the workers, of the fact that they must produce in order to enjoy the benefits of production. While there are many radical labor leaders who are still preaching strife and trying to stir up trouble, most of the influential labor leaders take a more conservative stand, and there is every reason to believe that, on the whole, British labor is settling down on a sound basis, and that there will be an increase in production.

Wages and Comparative Productiveness of British Labor

The average wages in the British metal industries—including all shop labor—are now just about 2 shillings an hour. The average output of the British workers, compared with that of the American shop men, is about two-thirds of the latter, in the mechanical industries. Hence, the cost of unit labor in England is as high or higher than in America, and British production costs today are much higher than pre-war costs. This condition will make it much more difficult for England to compete with America in the world's markets, everything else being equal, and is one of the most direct reasons for the decided tendencies toward the adoption of American methods. As soon as the industries have fully organized themselves for mass production, the output per wage unit will be greater, and England, of all nations, will bring to bear the greatest competitive pressure upon the United States. In no field is this truer than in the machine tool field, because here England has definitely set out to capture much of the former American market both in Europe and in non-European countries—especially South America and the Far East.

French Industrial Conditions of Today

France has had less labor disturbances than any other country in Europe. There have, of course, been local strikes, but none of these have been of national scope or significance. It is believed that the peak of the high wages has been reached. In the mechanical industries, this wage is now 3 francs per hour for the highly skilled men, compared with 1 franc per hour before the war. The average wage in the mechanical industries is 2 francs per hour, compared with 0.75 to 0.80 franc before the war.

France suffers from lack of coal, which interferes seriously with her industrial output and rehabilitation. In the districts that were unaffected by the war, full industrial activity cannot be resumed because of lack of labor, coal, iron, and steel. The reconstruction work in the devastated regions takes the labor from the industries not directly affected by the war, and thus no part of France is able to go ahead fullblast industrially.

There is, however, a carefully laid out program, on which both the government and French financial interests are working in harmony, for making France much more of an industrial country than before the war. Investors are placing their funds in French enterprises so that France may be able to produce more of the products to meet her needs right at home. The country is, however, seriously handicapped in carrying out this program by the fact that so large a proportion of the French iron and steel industries lie in the

devastated regions, and the reconstruction work is of necessity slow, in spite of all efforts to speed it up.

The French mechanical industries will concentrate on automobiles and trucks, airplanes, engines, turbines, and, in general, on machinery requiring highly refined mechanisms. They will probably not build machine tools to any great extent, although the few firms that have been in that field in the past are planning to increase their output somewhat. It is doubtful if France will ever supply her own needs in machine tools, let alone becoming an important factor in international machine tool trade. America and England will probably continue to supply France with a large part of her machine tools; and the machine tool building countries of the future will doubtless be the same as in the past—America, England, and Germany.

Machine Tools Bought from Germany

All of Europe is now buying commodities from Germany, and naturally machine tools are among the first, and certainly the most important, transactions. It was stated by a reliable authority that the exports of German machine tools already amount to 50,000,000 marks a month. This seems large but it does not represent so tremendous a volume when it is considered that the prices, expressed in marks, range from twelve to seventeen times the pre-war rates.

In spite of these increases in price, it is still economically of a tremendous advantage to France and Belgium and other European nations to purchase their requirements in machine tools from Germany instead of from the United States, on account of the great depression of the German mark and the high value of the American dollar. The situation is such that France and Belgium can buy for about one-half the price that they would have to pay for similar tools imported from the United States. It is doubtful whether Germany can continue to export at this rate because of her limited supply of coal and iron, and also because of the probable further increase in export prices in order to meet the difference in the rate of exchange.

The Germans are clamoring for some form of industrial protection. They feel that foreigners are buying them out, and that even at enormous prices in marks, their products, when bought with foreign currency, give the foreign buyers a tremendous advantage. The result of a great amount of trade on this basis further depresses the value of their currency in foreign markets.

There is a decided movement on foot to regulate export prices, which may be accomplished by quoting in the currency of the country to which the goods are being exported, or by determining the price in marks based on the current rate of exchange. Any steps in this direction will immediately counteract the economic advantages other nations now have in dealing with Germany.

Belgium is Recovering

Belgium is probably in a better industrial position than any of the continental nations, and she is pulling herself together more rapidly than the rest. She is better off economically, and food is better and more plentiful than elsewhere in Europe. An important factor in the rapid reconstruction was the sale of the United States Government machine tools to Belgian manufacturers, who thus obtained quick deliveries and have been enabled to re-establish their industries without much delay. That our country performed a distinct service in this respect is without a doubt. In France, the tools sold by our Government are held by the French government to be used for equipping the reconstructed factories in the devastated regions, and are not permitted to be sold to any other French industrial enterprises. Hence, in France, they have not yet been put to use.

Another factor that aided Belgium in her rapid reconstruction was the small size of her country, making it easy to organize for rehabilitation. Furthermore, few Belgian plants were utterly destroyed as were the French; the greatest difficulty was caused by the removal of the machinery to Germany, but the Belgian commissions that have been locating this machinery in Germany are now returning it by train-loads to Belgium.

The frightfully run-down transportation system provides a serious problem for both Belgium and France, the permanent way as well as the rolling stock being in very poor condition. German locomotives and cars are more largely used than Belgian or French; but even with this reinforcement, many trains, both passenger and freight, are cut off because of shortage of coal, especially in France.

Labor Conditions in Belgium

The labor situation has been more disturbed in Belgium than in France, but there has been no trouble of national importance. The people are getting back to work, and being naturally industrious, are showing results. The great industrial works and the coal fields in the Meuse valley appear to be working to their maximum capacity. Wages are about the same as in France, and probably will become somewhat lower as conditions are stabilized.

Belgium will devote herself to the same industries as in the past, with some development in the automobile industry where cars of high quality will probably be the Belgian standard. The old lines of industry, however, are being expanded, and Belgium will provide a good, but naturally limited, future market for machine tools.

Belgium has to find some way to dispose of the seven and one-half billion German marks called in by her government after the armistice. The only outlet for this amount is in exchange for German goods, and she is shrewdly satisfying her needs with a distinct economical advantage. France, likewise, will find it to her decided economic advantage to purchase goods from German factories so long as the dollar is at a high premium and the mark at a big discount.

The Dutch Industrial Expansion

Holland is going more strongly into the mechanical industries. Dutch factories now turn out a varied product—automobile parts, screw machine products, hardware, small tools, etc. Great projects are under way, and with the capital accumulated during the war, new industries are being financed. One plan is to develop the iron and coal resources of the Dutch East Indian possessions, especially of Java, and to bring the iron and steel from there to Holland for its final manufacture into finished products. During the war many manufacturers in Holland had to build their own machine tools—copies of American, English, and German makes—as they were unable to buy from abroad. But now that the world's markets are again open to them, they will not continue to produce machine tools in any appreciable quantity. The Dutch are good business men and have taken advantage of the depreciation of the German mark, having invested largely in German industries and bought other properties in Germany.

Present Conditions in Germany

The conditions in Germany are not generally understood in the United States, because they are so abnormal. There has been a mental and moral collapse since the war. Life is viewed with indifference, and it is as if the whole people suffered from a mental fever that must run its course. The cost of living is fully ten times what it was before the war. The average wages in the mechanical industries are from 2½ to 3 marks per hour. Rates are constantly increasing, and as the exchange falls still further, the cost of living and wages will increase proportionately. The attitude of the workers in the industries is one of apathy. They try to get all the wages they can, and perform as little work as possible. The working day is eight hours. Food is scarce and food cards are still in use. White bread is unknown, and meat almost as rare.

The industrial situation is very unsatisfactory, both on account of the attitude of labor and because of the shortage

of raw materials. Strikes are the order of the day, and when working, the production per man per day is low. Coal, iron, and steel are lacking, and transportation facilities are very poor. There is a tremendous shortage of rolling stock, and what there is, is in a run-down condition. Where formerly there were eight or ten passenger trains in each direction there is now only one. The freight service is equally curtailed. Everything looks neglected—everything is permitted to run down shiftlessly. The uncertainty of the indemnity has something to do with this. There is a feeling that whatever is produced will go toward the indemnity.

Industrial leaders in Germany are doing little at present to remedy the situation. They look upon the conditions as a disease. They believe that in time, perhaps one or two years, the distemper will have run its course, and then Germany will gradually come back; but even after that it will be years before Germany will regain her industrial footing.

In the machine tool field, Germany now offers some competition; but that will last only as long as present stocks and raw material last. After that there will be a period when German machine tool competition will not be very serious. When Germany finally gets on her feet the machine tool industry will be among the first to revive, and the Germans will then make a very decided drive to regain their lost trade. It will be pushed with vigor, as will their other industries. During the war, while Germany was completely cut off from all the other big industrial countries of the world, and entirely depended upon herself, she made many copies of well-known foreign makes of tools and in other cases embodied the principles of foreign equipment.

Her industrial units are practically intact. Given raw material, fuel, and a stable labor market she will again quickly become a factor in world production. She will probably never again revert to the low price levels of pre-war years, and given anything like a normal rate of exchange on which to fix prices in international trade she will have to rely more upon merit than price in the world's markets.

The Exchange Situation

Much has already been said and written about the exchange situation. This affects practically all the European countries, but of course to a much lesser degree the neutrals, particularly Holland and Spain, whose currency relations with the American dollar have not materially altered. The main point is that the exchange rates cannot return to normal until we buy from Europe at least as much as we sell, and for a time a great deal more.

The extension of credits alone is not a cure, and while they must be extended in some form with the result that temporarily a still more unfavorable exchange will result, such credits should be limited to what is necessary in order to give the European nations an opportunity to begin production on a large scale. Europe must produce and sell in large quantities, and we must be prepared to buy in large quantities the goods we require. We cannot hope to right present conditions by selling vastly more than we purchase.

Many methods of credit extension have been proposed, most of which are nothing more than gambling on exchange rates. The most constructive plan appears to be the extension of credits in the form of raw material to be worked into the finished products by the European factories, and then shipped to the credit givers, or to some market for their account. This scheme is being given serious consideration in several directions.

For example, we learned of negotiations between American interests and a large German shipbuilding firm, which contemplate furnishing the yard with all the raw material necessary for the construction of ships. Thus the yard would have the benefit of the work to do, keep labor and equipment employed, and obtain a profit on the actual work performed. In other words, the yard would be a sort of job shop. Trade experts from other foreign countries are studying similar plans in other industries. The fundamental need is to get the shops of the world to work again.

ADOPTION OF A STANDARD SAFETY CODE

As a result of a conference called by the Bureau of Standards at Washington, a movement has been started to create a uniform national safety code, so that the rules and regulations relating to the safeguarding of machinery in the industries may be uniform in the different states. The program includes a method for unifying the large number of conflicting safety codes in existence, which have been formulated by various state authorities and by insurance and other organizations. It is planned to formulate these safety standards under the general auspices of the American Engineering Standards Committee, which was recently organized by the five national engineering societies and the War, Navy, and Commerce Departments of the United States.

The proposed procedure is as follows: If a standard is desired on any engineering subject whatsoever, the American Engineering Standards Committee will designate some organization to act as a sponsor in the formulation of such standard. This sponsor may be an engineering or manufacturing association, a government bureau, etc., and need not be a member of the committee. The sponsor body then organizes a representative committee to have charge of the formulation of the standard or code in question, this committee including representatives of all organizations and interests affected by the proposed standard, regardless of whether such organizations are members of the main committee. In other words, the representative character of this code committee insures that the standard to be formulated will be a reasonable one, having due regard to all parties interested. The code or standard as prepared by this committee must then be approved by the sponsor body and finally by the American Engineering Standards Committee—the latter, however, not going into the details of the code, but merely satisfying itself that the code has been prepared with proper regard for all interests involved.

* * *

INDUSTRIAL TRAINING SCHEME

A unique educational project has been developed at Spartansburg, S. C., in connection with the Textile Industrial Institute of that city. A modern mill for instruction purposes has been built, which is said to be one of the finest mills in the world in its appointments. The students will operate the mill as part of their instruction in the Textile Institute and will manufacture a line of high-grade cotton cloth which is to be sold direct to consumers by means of the parcel post. Every student in the mill will be given special training in the classroom, so that he will understand the theory of the process upon which he is engaged. The student is expected to be self-supporting, working every other week in the mill and receiving sufficient pay to cover his living expenses for two weeks. There are to be two separate student organizations, each having a superintendent, overseers, etc.

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HOOVER ELECTED PRESIDENT OF MINING ENGINEERS

The American Institute of Mining and Metallurgical Engineers has elected Herbert Hoover as the next president of the institute. Barring the names of President Wilson and General Pershing, Mr. Hoover's name is perhaps better known than that of any other American, both at home and abroad. Mr. Hoover received his early training at the Stanford University, California. He then served with the United States Geological Survey and was later engaged in mining activities in Australia and China. He has also been consulting and managing engineer in metallurgical, mining, and railway operations in Mexico, Russia, Africa, and India. Directly after the beginning of the war he became active in various kinds of war services, and in October, 1914, organized the Commission for the Relief of Belgium. His activities from that time on are too well-known to require mention.

View on the Hotel Astor Roof Showing Arrangement of Booths

Convention and Exhibit of American Society of Mechanical Inspectors

THE first annual convention, in conjunction with an exhibition of mechanical inspection equipment, held by the American Society of Mechanical Inspectors, at the Hotel Astor, New York City, February 2 to 6, gave evidence of the great activity and enterprise of this society, which promises to place it in an important position in relation to the mechanical industries in the future. During the convention the following papers were read, relating to important phases of gaging and inspection: "The Need of Inspection Laboratory Education," by H. F. Winter, secretary of the American Society of Mechanical Inspectors, New York City; "Tolerances and Allowances," by Irvin H. Fullmer, associate physicist, Gage Section, U. S. Bureau of Standards; "American Advancement in Precision Measuring Appliances," by B. H. Blood, general manager, Pratt & Whitney Co., Hartford, Conn.; "A Few High Lights on Gage Practice," by A. W. Schoof, gage engineer, Greenfield Tap & Die Corporation, Greenfield, Mass.; "Inspection Practices," by Frank Higgins, superintendent of inspection, Willys-Morrow Co., Inc., Elmira, New York.

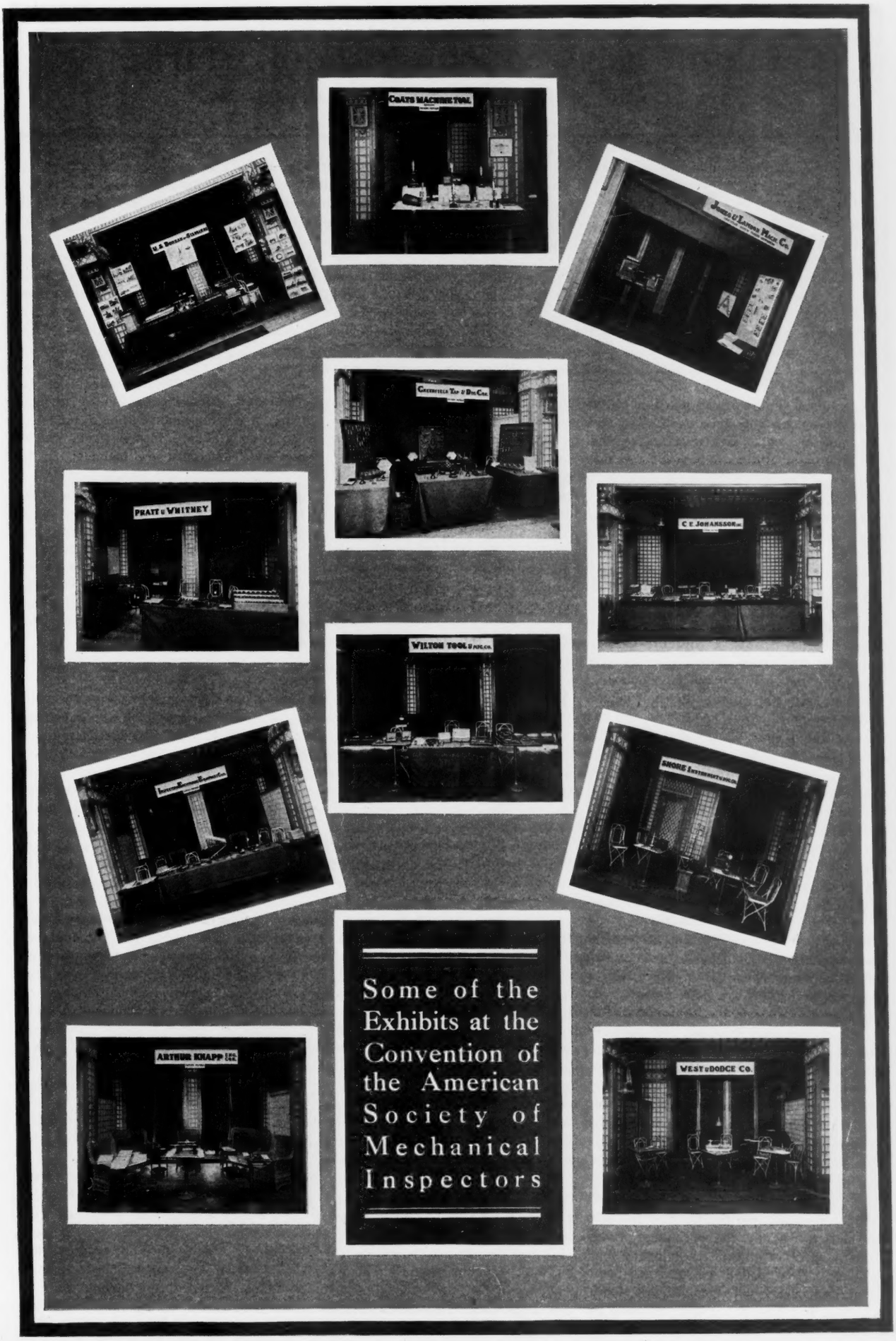
In connection with the convention, the society had arranged for an exhibit of inspection equipment for the mechanical industries, and this exhibit proved to be one of the valuable features of the convention. The Gage Section of the United States Bureau of Standards had an exhibit which included apparatus for testing the length, flatness, and parallelism of the faces of precision gage-blocks to a millionth of an inch by optical methods. The bureau also had on exhibition a projectograph for the checking of thread profiles of thread gages. In addition, there were exhibited a number of other devices including a universal sine plate fixture for testing angles and radii of profile gages and templets; Hoke precision gage-blocks as manufactured by the Bureau of Standards; a lead-testing device built at the bureau; a set of precision balls ranging from 1/16 inch to 4 inches in diameter; a balance micrometer for measuring the pitch diameter of thread gages by the three-wire method; various gages; and photographs illustrating methods of testing gages.

Among the commercial exhibitors were the following: William Brewster & Co., New York City; Coats Machine Tool Co., New York City; Greenfield Tap & Die Corporation, Greenfield, Mass.; Holz & Co., Inc., New York City; C. E. Johansson, Inc., Poughkeepsie, N. Y.; Jones & Lamson Machine Co., Springfield, Vt.; Inspection Engineering Equipment Co., New York City; Arthur Knapp Engineering Corporation, New York City; Pratt & Whitney Co., Hartford, Conn., Shore Instrument & Mfg. Co., New York City; West & Dodge Co., Boston, Mass.; Wilton Tool & Mfg. Co., Boston, Mass.

In addition there were exhibits by the College of the City of New York in connection with its evening courses in mechanical inspection, machine shop practice, automobile and aeronautical engineering, etc. The Inspector Publishing Co., which publishes the official organ of the American Society of Mechanical Inspectors, *The Inspector*, also had a booth. MACHINERY also had an exhibit of the work that this journal has done along gaging, inspection, and similar lines, and of the books published by MACHINERY on gaging, inspection, toolmaking and machine shop practice, and design in general.

The following officers for the coming year were elected: President, Paul E. Theis; vice-presidents, Ernst Mentor, technical supervisor, C. E. Johansson, Inc.; Arthur Knapp, president, Arthur Knapp Engineering Corporation; Benjamin Gilpin, factory manager, Remington Typewriter Co. plants; Guy W. Vaughan, vice-president and general superintendent, Van Blerck Motor Corporation, Monroe, Mich.; Earle Buckingham, engineer, Pratt & Whitney Co.; Albin Rothoff, president, Rothoff Tool & Mfg. Co., Brooklyn, N. Y.; treasurer, H. L. Bailey, service manager, Chevrolet Motors Corporation, Metropolitan Headquarters; secretary, H. F. Winter.

One of the features of the convention was the dinner on the opening night, which was attended by about seventy members and guests of the society, and at which a number of men prominently connected with the gaging and inspection equipment industry spoke on subjects of importance to this branch of the industry.


COATS MACHINE TOOL
PRATT & WHITNEY
C. E. JOHANSSON
WILTON TOOL
ARTHUR KNAPP
WEST & DODGE CO.
Some of the Exhibits at the Convention of the American Society of Mechanical Inspectors

China as a Machine Tool Market

By JULEAN ARNOLD, American Commercial Attache, Peking, China

Julean Arnold, American commercial attache at Peking, China, gives his views of the possibilities of a future machine tool trade with China in this article. He outlines the present conditions in China's industrial developments and points out that the Chinese engineering schools provide one of the best means for advertising American machine tools to the Chinese. Mr. Arnold, having lived in China for eighteen years, during which time he has been intimately in touch with the industrial conditions there, is able to speak authoritatively on this subject, and his views should be of interest and value to American manufacturers.

THE imports of machine tools into China during past years have not been large enough to make American machine tool builders realize that there is a potential market for machines of this kind in China. The last few months' imports of machine tools into China have amounted to about $10,000 a month, which, of course, seems unimportant. But the fact that should be impressed upon the American machine tool builder is that there is at present an industrial awakening in China, which, without question, will greatly increase the foreign trade in machine tools within a few years. As an example, it may be mentioned that at the present time thirty cotton mills are being built in China, each one of which is provided with a small machine shop for repair work and minor alterations on machinery. The iron and steel industries have also been developed to an important degree during the past few years, and China is now beginning to make use of its vast natural resources in iron ore and coal, the value of which was not appreciated or understood by the Chinese themselves until within recent years. Railway building is likely to have an unprecedented growth within the next decade, because the Chinese realize the necessity of more railroads, and the only thing that has held up the development has been the difficulty of financing during the war period. There are only 6500 miles of railways in China—in a territory larger than that of the United States and with a population at least three times as large. With the coming industrial development of China, more railways must be built, and this will mean more repair shops and even new industries for the building of railway cars and locomotives. To one that has seen the development of China during the last ten or fifteen years, it is easy to imagine what the next ten or fifteen years can bring, provided foreign interests, particularly American, will take the lead.

Cooperation between American and Chinese in Industrial Developments

At this point it should be emphasized that the Chinese are more friendly to the Americans than to any other foreign nation, and that cooperative enterprises in which American and Chinese capital are both represented, are greeted with much favor. America has the good-will of the Chinese, and if Chinese business men see that American capital can be interested in a Chinese undertaking, they will also come forward with capital, because there is a great deal of capital in China lying dormant, which can be brought into active play only by foreign, particularly American, activities. Many large American enterprises are now entering into this field in various industrial lines, and as more industries are being established in China, the demand for machine tools is sure to grow.

How Chinese Trade can be Encouraged

At the present time the Chinese trade in machine tools is too small to warrant the individual American machine tool builder's going after this trade by the use of a direct representative. There are, however, a number of big firms representing American machine builders in China, especially in Shanghai, and one of the best methods for obtaining information about the details of the Chinese trade would be for the American machine tool builder interested in this market, to get in touch with the American Chamber of Commerce at Shanghai or with the Bureau of Foreign and Domestic Commerce at Washington. The Bureau can assist a great deal in spreading knowledge about American machinery and methods in China, if manufacturers will take advantage of the facilities at their command. One method which is being employed is the showing of moving picture films of industrial subjects. Chinese business men are interested in moving pictures showing how the industries are managed in the United States. The pictures should not be too technical in their nature, but should deal with their subject in a broad, general way, showing for example, the general lay-out of plants and their appearance, the use of labor-saving devices, the results of systematic methods, and the production obtained by modern machine tools. These films should be sent to the Bureau of Foreign and Domestic Commerce, Washington, with instructions that they be forwarded to the commercial attaché, Peking, who will see that they are effectively circulated and used.

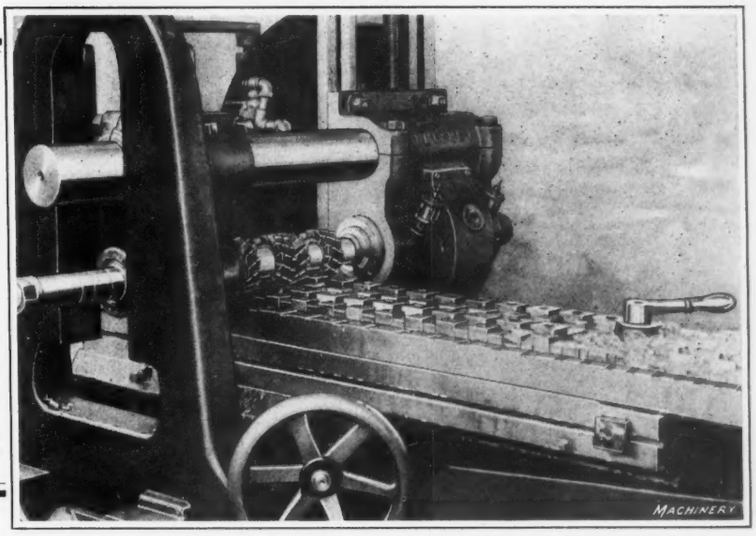
Chinese Engineering Schools a Good Advertising Medium

It is believed that one of the best ways in which the value of American machine tools could be brought to the knowledge of the Chinese would be through their introduction into the Chinese engineering schools. Previous to the war, the Germans maintained an engineering college in Shanghai, and by this means were able to greatly further the German trade with China in the products of the machine building industries. The British maintain an engineering college at Hongkong; and the British, French, and Japanese have also taken advantage of the opportunity to place machinery built by them in the engineering schools of China, thereby acquainting the students with these machines.

It has proved difficult to interest American manufacturers in this method of advertising their machines, but doubtless this method is both cheaper and more effective than the exposition of machinery at great industrial fairs. American manufacturers are willing to spend large sums of money in order to exhibit their machines at an exposition where they are only temporarily on exhibit; but they have shown very little interest in the permanent exposition of their machines that they would get in an engineering college where the future leaders in Chinese industries are being educated. The office of the American commercial attaché at Peking will give all the information required by an American manufacturer interested in this phase of the subject. It is desirable that the machines be given outright to the colleges, but if this cannot be done, they may be sold on favorable terms. The main thing is that the interest of the American machine tool builders is aroused and that they give some attention to this matter. The Chinese market is not large at present, but it will be large in the future, and it is a question whether American machine tool builders or those of Great Britain, France, Germany, and Japan will get the biggest part of this market. Now is the time to lay the foundation for our future business there.

Indexing Milling Fixtures

Second of a Series of Three Articles on the Use of Indexing Fixtures for Obtaining Increased Production in Milling Practice



IN the first article in this series, published in the February number of MACHINERY, some of the general principles involved in the solution of the problems for obtaining increased production in milling practice, were dealt with, and a general review was made of the general types of indexing fixtures in common use. Several examples of these fixtures were illustrated and described. The present article continues this description, dealing specifically with the indexing type of string fixtures, and other special indexing fixtures.

Indexing Type of String Fixture

At the plant of the Armstrong Mfg. Co., Bridgeport, Conn., No. 33 Lincoln type milling machines, built by the Kempsmith Mfg. Co., of Milwaukee, Wis., are used for face-milling operations on blanks for pipe-threading dies. One of the machines equipped for these operations is shown in the heading illustration and in Fig. 10, which illustrate opposite sides. It will be apparent from these illustrations that the miller is provided with a rather unusual type of work-holding fixture, which combines features of the so-called "string" and "indexing" types. In other words, this tool consists of two stations, on each of which there are mounted clamps for holding four strings of pieces to be milled. The fixture is mounted on a pivot, and while the milling operation is being performed on pieces set up in one station, the operator has ample time to unload the milled parts from the other station and substitute fresh blanks. It will be seen that the four plain milling cutters that are used for the performance of this operation are set up on the arbor with the spiral angles of the teeth opposed to each other, the purpose being to have these four cutters arranged in opposed pairs to neutralize the end thrust.

In designing a fixture of this type, the main table *A*, on which the work is mounted, is carried by a pivot mounted in an intermediate plate *B*, which is secured to the table of the milling machine. At the left-hand end of the table, there will be seen a notch *C*, and there is a similar notch at the right-hand end. This is the locating point for the tapered index-pin which locates the fixture in either of the two positions in which it is used. It will, of course, be apparent that after indexing the table must be clamped, and this is done by a binder manipulated by lever *D*. In the performance of this operation, the cutters are driven at a speed of 56 feet per minute, and the work is fed to the cutters at a rate of 3 9/32 inches per minute. The material being milled is carbon tool steel.

Indexing Fixture for Face-milling Connecting-rods

A No. 3 plain Kempsmith milling machine is illustrated in Fig. 11. This machine is used by the Holt Mfg. Co., of Peoria, Ill., for the performance of straddle-milling operations at both ends of connecting-rod forgings. As the bearings to be faced are of different widths at opposite ends of the work, it is obvious that the man who planned the method of machining had to choose between the alternatives of resetting the work for performing the second milling operation, or else provide for indexing the fixture in order to reach the opposite ends of the forgings. The latter plan was adopted, and in order to secure constant operation of all of the four pairs of cutters which are placed on the arbor for milling opposite ends of these forgings, the fixture was designed to hold two forgings, with their small ends facing the cutters, and two other forgings with their large ends facing the cutters. With this arrangement, the ends of four forgings are straddle-milled simultaneously, after which the fixture is indexed to provide for milling the opposite ends of the same forgings.

It will be seen that this machine is set up with a fixture at each end of the table, the purpose being to avoid the necessity of having the machine idle while the operator is removing milled forgings and reloading the fixture. With a machine set up in this way, the sequence of operations is as follows: First, mill one end of the forgings held in the left-hand fixture; second, traverse the table over to mill one end of the forgings held in the right-hand fixture; third, index the left-hand fixture while pieces held in the right-hand

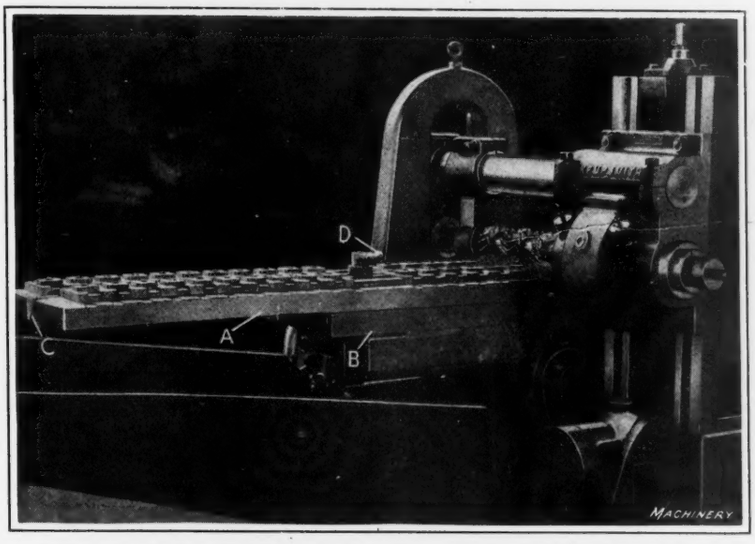


Fig. 10. Milling Threading Die-blocks, using a Fixture which combines Features of the Indexing and String Types of Equipment

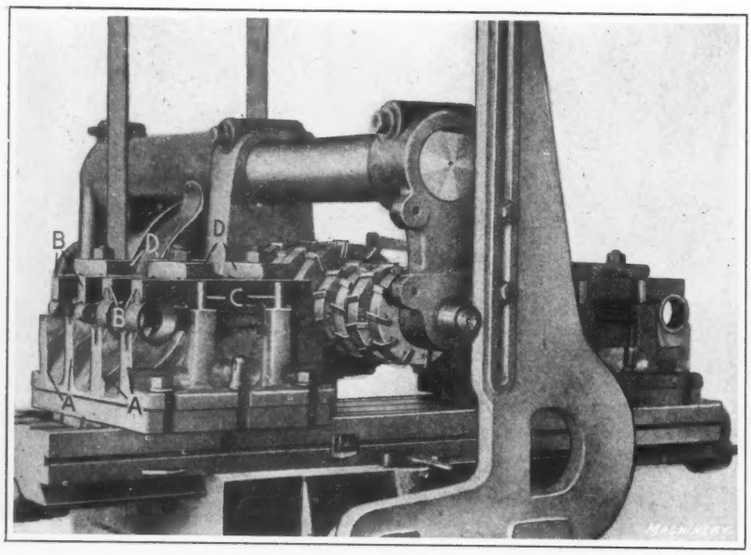


Fig. 11. Straddle-milling Both Ends of Connecting-rod Forgings. One Fixture is loaded while Forgings held in the other Fixture are being milled

fixture are being milled, and then traverse the table over to complete milling the forgings held in the left-hand fixture; fourth, index the right-hand fixture while the other milling operation is proceeding, and then traverse table over to complete milling the forgings held in the right-hand fixture. While the final operation is being performed on the forgings held in this fixture, the completely milled connecting-rods are removed from the other fixture and fresh forgings are set up. In this way, excellent rates of production may be obtained, as there is practically no idle time for either the machine or its operator. This fact is well demonstrated by results obtained with the equipment shown in Fig. 11 at the Holt plant, where 400 connecting-rods are milled in a ten-hour working day.

It will be of interest to briefly describe the way in which the forgings are held in this fixture for performing the milling operation. Each fixture is provided with four walls *A* in which transverse V-notches are cut to receive the bearings at each end of the connecting-rod, and longitudinal grooves to receive the bolt bosses. After four rods have been dropped into place, four bars *B* are placed on top of them. These bars also have been provided with longitudinal grooves and transverse V-notches to conform with the contour of the work. It is necessary to obtain sidewise adjustment of the work (longitudinal adjustment is effected by the V-blocks in which the work is carried), and this is accomplished by having pins *C* engage the finished sides of bars *B*. After the desired location has been secured for each of the four rods, straps *D* are tightened, four of these straps being provided for holding down the bars *B* and the connecting-rods secured by them. With a fixture designed in this way, the machine operator is allowed ample time to remove the milled forgings and substitute fresh parts while the remaining operation is being performed on parts held in the opposite station of the fixture.

Milling Spring Shackle Forgings

At the plant of the National Motor Car & Vehicle Corporation, Indianapolis, Ind., use is made of horizontal milling machines built by Gooley & Edlund, Inc., Cortland, N. Y., which are equipped as shown in Fig. 12 for use in milling spring shackle forgings. It will be apparent from the line illustration of the work, Fig. 13, that there are eight surfaces to be milled, and this result is accomplished by a gang of eight milling cutters which provide for simultaneously machining four surfaces on each of the two shackles which are mounted in the fixture. In order to conserve the operator's time by enabling him to be kept constantly employed in setting up work on the machine, a duplex fixture is provided which allows the workman to set up new forgings in one fixture while the machining operation is proceeding on pieces held in the other fixture. The method of procedure is as follows: When a milling operation has been completed on the two shackles held in the first fixture, the table is traversed over to provide for bringing the forgings held in the second fixture at the opposite end of the table into place to provide for milling them with the opposite sides of the cutters carried on the milling machine arbor.

While this operation is progressing the operator removes the milled pieces from the first fixture and sets up forgings in their places. By this time the ends of the shackles on which the milling operation was being performed will have been machined and the table may be traversed over to perform the first step of the milling operation on pieces held in the first fixture. While this operation is proceeding, the machine operator indexes the second fixture through an angle of 180 degrees to provide for bringing the opposite ends of the forgings into position for milling. The next step will be to traverse the table to bring these pieces into the operating position for the final milling operation, and while this machining is in progress the first fixture will be indexed ready to complete milling the pieces carried in it. The cycle of operations will be finished by feeding these forgings up to the milling cutters, after which the finished spring shackles will be removed from the second fixture.

This milling operation is performed with cutters 6 inches in diameter, which run at a speed of 40 revolutions per minute. Quick traverse is used for bringing the work into position for milling, after which a feed of 1 inch per minute is employed for the actual machining. Each milling cutter is required to face off a round surface on the spring shackles which is 1½ inches in diameter, and approximately 3/32 inch of stock is removed from each face. The rate of production on this job is 22 completely milled spring shackles per hour. It will, of course, be apparent from the illustration that the work-holding fixture is of very simple design. It consists merely of a bridge carrying two screw-operated clamps which hold the pieces down on a pad at the base of the fixture. A

Fig. 12. Straddle-milling Spring Shackle Forgings; the Two Fixtures on the Table are used alternately

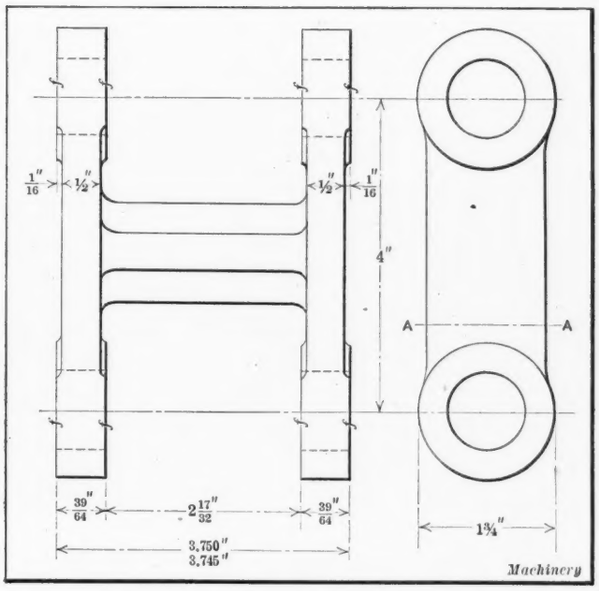


Fig. 13. Design and Dimensions of Spring Shackles milled on Machine shown in Fig. 12

simple form of locating bolt provides for securing each fixture in either of the two stations in which it is required to operate.

The third and last installment of this series, which will be published in the April number of MACHINERY, will describe additional special types of indexing fixtures which can be used to advantage for milling operations on a quantity basis.

* * *

BLUEPRINT PROTECTOR

A means for protecting blueprints while handled in the shop so as to prevent them from getting dirty, wet, greasy or torn has been developed by E. I. Du Pont De Nemours & Co., Inc., Wilmington, Del. This blueprint protector consists of a sheet of transparent material cut to the desired size. A piece of thin leather substitute fabric is then cut about ½ inch larger all around than the piece of transparent material. This extra ½ inch allows for overlap on all but the top side of the protector. The lap is stitched down to the transparent sheet so that a large flat pocket is formed, open at the top for the insertion of the blueprint. The transparent material from which the face of the protector is made is flexible so that the holder may be rolled up, if desired, in the same way as an unprotected blueprint; and as both the transparent face and the leather substitute back are water- and grease-proof, the blueprint can be kept in good condition.

PLANER FIXTURE FOR HOLDING TRAILER-BOX SHELLS

By NORMAN McCLEOD

One of the most difficult problems encountered in machining brass trailer-box shells is that of holding the work in place on the planer bed when planing the 45-degree surface shown at *F* in the accompanying illustration. This is especially true when the demands for quantity production make it desirable to fasten as many castings to the planer bed as can be conveniently machined at one time. The fixture shown at *C*, designed for a double-head planer has a capacity for two shells and has proved an efficient and economical means of solving this problem. The casting which constitutes the main body of the fixture has a locating seat *G*, planed at an angle of 45 degrees with its base.

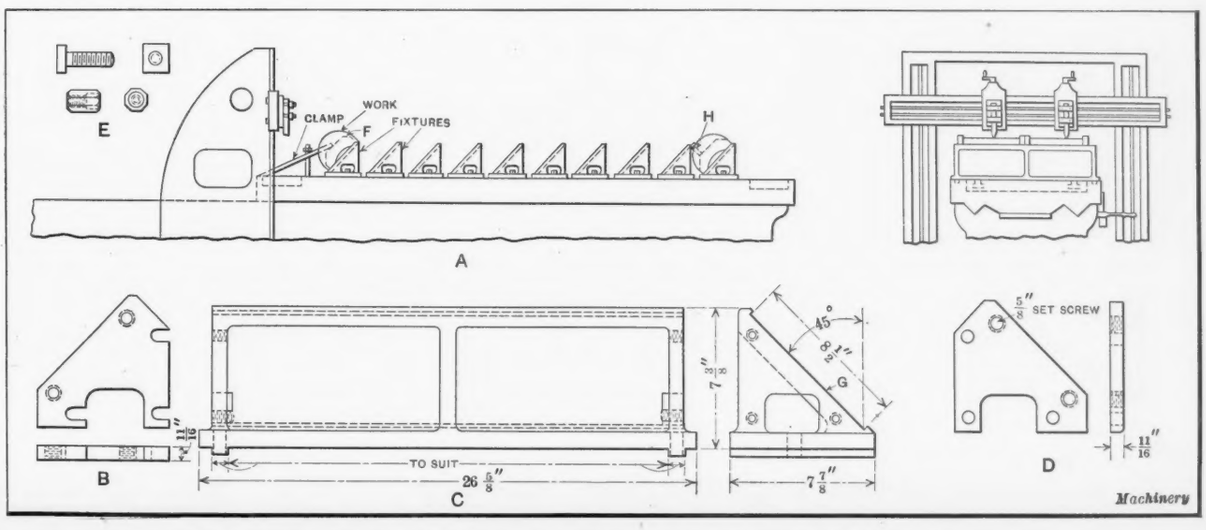
The plate shown at *D*, which is attached to the right-hand end of the casting *C* by means of cap-screws, is provided with two ⅝-inch set-screws which act as stops for locating the work laterally. The plate shown at *B*, which is attached to the opposite end of the fixture, is also provided with two set-screws, which when tightened serve to hold the work in place. In order to facilitate loading and unloading, the cap-screw holes in plate *B* are slotted, so that the plate may be readily removed from the end of the fixture by simply loosening the three cap-screws.

In addition to the set-screws employed to hold the work in place, each fixture is provided with two special bolts and nuts such as shown at *E*. When in use, these bolts are set as shown at *H*, the head of the bolt bearing against the top of the preceding fixture while the hollow pointed nut contacts with the work, and is adjusted to bind the piece in place.

The planer bed shown at *A* in the illustration is 96 inches long by 32 inches wide and readily accommodates ten fixtures, thus permitting twenty trailer boxes to be planed at one time. When loading the fixture, plate *B* is removed, and two shells are slid into place along the fixture, located in the 45-degree recess. By adjusting the set-screws in the end plates the work can be properly centered so that both rows of castings will be finished to the required dimensions simultaneously.

* * *

Of the 75,288,851 gross tons of iron ore mined in the United States in 1917, the Lake Superior district produced nearly 85 per cent, and the Birmingham district 8 per cent. The Lake Superior district furnishes ore to the great pig-iron producing centers in Pennsylvania and Ohio, and the Birmingham district is the center of the iron-making industry in the southern states. The imported ore is of comparatively little importance, being not more than one or two per cent of the quantity annually mined in this country.



Planer Fixture employed to hold Trailer-box Shells, and Method of mounting Fixtures on Planer Bed

Hand Screw Machine Practice

Examples of Work Finished in the Hand Screw Machine—Based on the Practice of the Warner & Swasey Co., Cleveland, Ohio

HAND screw machines are often considered as machines to be used only in the production of small parts, the machining of which is a comparatively simple proposition, and the purpose of this article is to show how this type of machine can be employed for other purposes. Examples have been selected which show how these machines are used to finish castings and produce comparatively long parts from bar stock. These examples are typical of the work performed in the shops of the Warner & Swasey Co., Cleveland, Ohio, on machines of its manufacture. In each case, a dimensioned drawing of the work is presented as well as a diagram of the tooling equipment used in finishing or producing the part, and one or more photographs of the set-up of the tooling equipment on the machine employed. The total time required to machine each part is given, which includes the time consumed in placing the work in the chuck and removing it. The various steps in each chucking are described in detail so that the reader will be able to thoroughly understand the methods employed and know what types of tools are used in each step. The surfaces of the castings finished by the tooling equipments to be described are indicated by heavy lines in the illustrations that show the dimensioned drawings of the castings. The same reference letters are used in each case, both in the drawing of the part and in the tooling lay-out, to indicate the same surfaces.

Machining a Differential Gear Case—Flange Side

Fig. 1 shows a malleable iron differential gear case for an automobile, which is finished in two chuckings on a No. 6 geared friction head turret screw machine. The total time required to machine this part is 7.5 minutes, the first chucking requiring 5.3 minutes. A lay-out of the tooling equipment employed in this chucking is shown in Fig. 2. A dot-and-dash outline of the work is shown in this illustration with each tool-holder mounted in the turret, so as to indicate clearly the method of finishing the various surfaces. In the first chucking the hole *A* is machined and all other

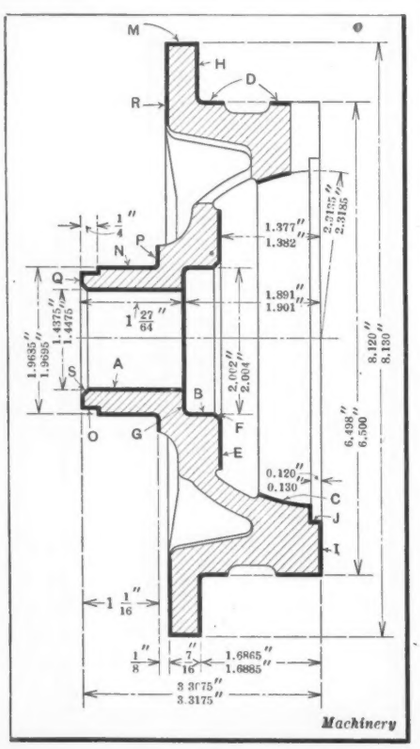


Fig. 1. Differential Gear Case

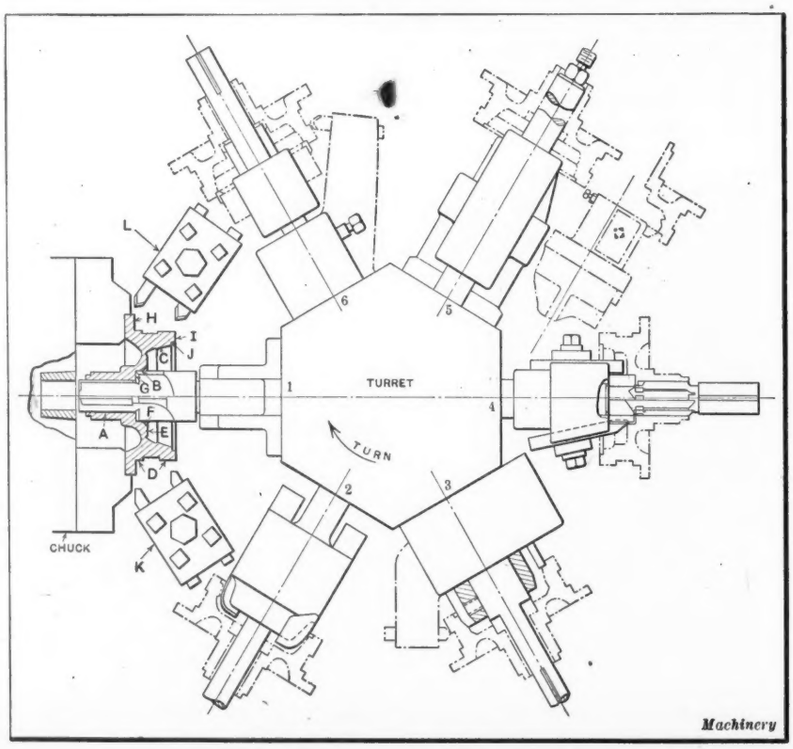


Fig. 2. Tooling Equipment for finishing Part shown in Fig. 1

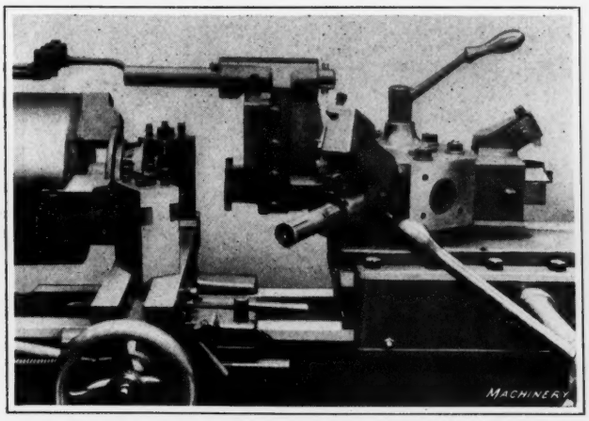


Fig. 3. Machine provided with Equipment for First Chucking on Differential Gear Case

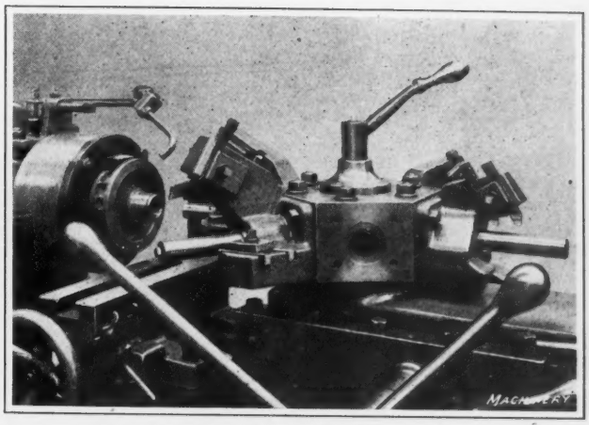


Fig. 4. Set-up of Machine employed for Second Chucking on Differential Gear Case

finished surfaces on the right-hand side of the casting, when viewing it in the position shown in Fig. 1. The various steps in machining these surfaces are taken in the following order: (1) The work is placed in a chuck equipped with jaws that grip it along the periphery of the flange. The headstock spindle is provided with a bushing which receives the pilots on the various tool-holders mounted in the turret, thus correctly locating the tools and producing concentricity of the work. (2) Hole *A* is reamed and surface *B* counterbored by the chucking reamer and counterbore held in the tool-holder in Face 1 of the turret. At the same time, rough cuts are taken on surfaces *H* and *I* with the tools held in tool-block *K*. (3) Surface *C* is rough-turned by the cutter mounted in the cutter-head held in Face 2 of the turret. (4) Surface *D* is rough-turned, another cut is taken on surface *C*, surface *E* is rough-faced and surface *J* is rough-bored by the tools mounted in the box-tool held in Face 3 of the turret. The tool which takes the cut on surface *D* is indicated by dot-and-dash lines, its normal position being on the upper side of the box-tool. (5) Hole *A* is reamed, another cut is taken on surface *B*, surface *E* is finish-faced, surface *F* is chamfered, and surface *G* is finish-faced by the tools mounted in the tool-holder held in Face 4 of the turret. At the same time, surfaces *H* and *I* are finish-faced by the tools mounted in tool-block *L*. (6) Surface *C* is finish-turned with the single-point tool mounted in Face 5 of the turret. This tool is indicated by dot-and-dash lines, its normal position being in a vertical plane which can be readily seen by referring to the view of the tooling equipment shown in Fig. 3. This view shows the machine just prior to the sixth step; however, at the time the photograph was taken, the tool-holder and tool used in Face 1 of the turret had been removed. (7) Surfaces *J* and *B* are reamed by the reamer mounted in the box-tool in Face 6 of the turret, and surface *D* is finish-turned by a tool held in the same box-tool. The tool used for reaming surface *J* and the tool used for finish-turning surface *D* are indicated by dot-and-dash lines. (8) the work is removed from the chuck.

The operations in the second chucking on the gear-case are performed in 2.2 minutes, and consist in finishing the surfaces on the left-hand side of the part. There is no diagram shown of the tools employed in this chucking, but a good idea of the equipment can be obtained by referring to the illustration, Fig. 4. The various steps in the second chucking are performed in the following sequence: (1) The work is secured in a special jaw chuck. (2) Surfaces *M*, *N*, and *O*, Fig. 1, are rough-turned and surfaces *P* and *Q* are rough-faced by tools mounted in a box-tool which is held in the turret. At the same time, surface *R* is rough-faced by a tool mounted in a toolpost on the cross-slide. (3) Surfaces *M*, *N*, and *O* are finish-turned, surfaces *P* and *Q* are finish-faced, and chamfer *S* is produced by tools mounted in a box-

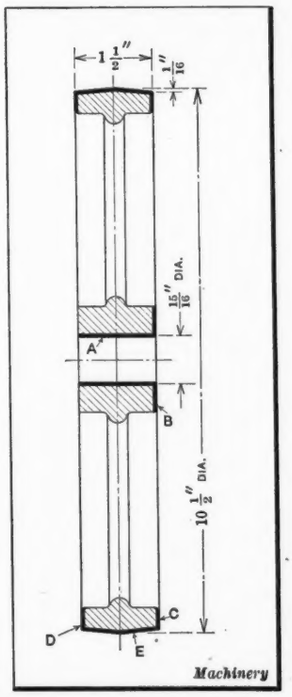


Fig. 5. Drawing of Pulley

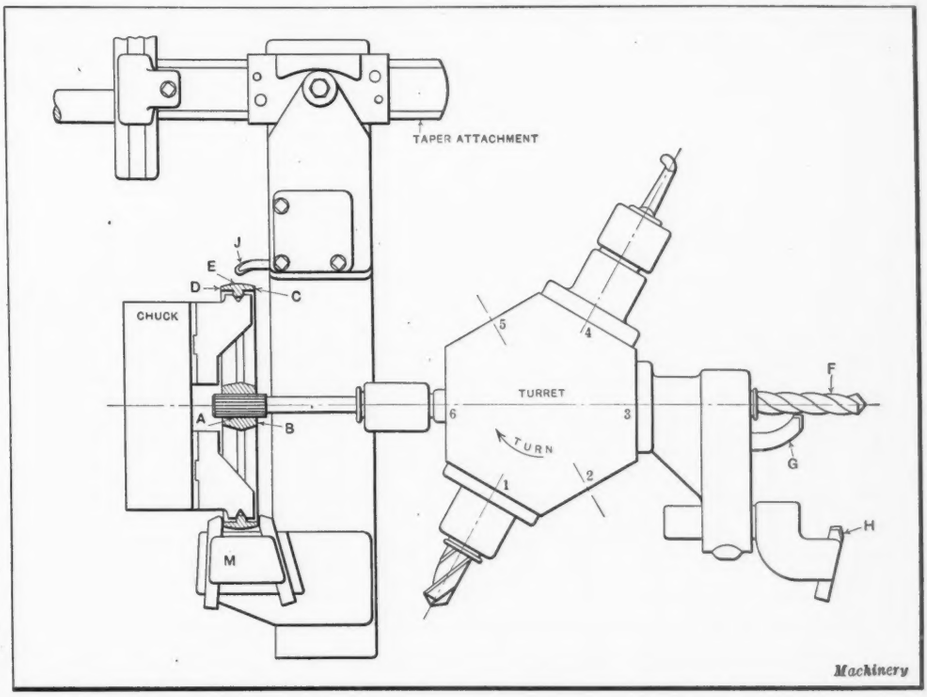


Fig. 6. Lay-out of Tooling Equipment used in machining Pulley shown in Fig. 5

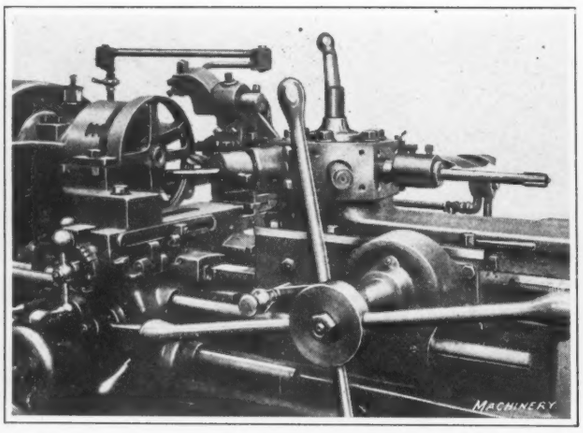


Fig. 7. Machine engaged in finishing Pulley shown in Fig. 5

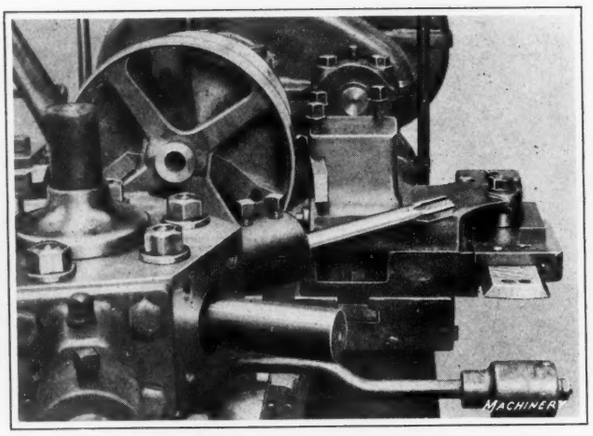


Fig. 8. Same Machine, showing Taper Attachment

tool held in the turret, while surface *R* is finish-faced by a tool mounted in a toolpost on the cross-slide. (4) The work is removed from the chuck.

Tool Lay-out for Finishing Pulleys

Cast-iron pulleys of the type shown in Fig. 5 are machined in one chucking on a No. 4 universal turret screw machine, which is provided with the tooling equipment illustrated in Fig. 6. The operations in this chucking consists of finishing hole *A* and surfaces *B*, *C*, *D*, and *E*, and are performed in 6½ minutes. The successive steps are as follows: (1) The work is placed in a chuck having jaws which grip it along the inside of the pulley rim. (2) A spot is drilled in the center of the face of hub *B* by the starting drill held in the tool-holder mounted in Face 1 of the turret, preparatory to drilling hole *A*. (3) Hole *A* is drilled by drill *F*, hub *B* is faced by cutter *G*, and surface *E* is rough-turned by cutter *H*, all of these tools being mounted in the multiple turning head in Face 3 of the turret. (4) Hole *A* is bored with the cutter held in the adjustable boring cutter holder in Face 4 of the turret. (5) Hole *A* is reamed by the reamer held in the floating tool-holder mounted in Face 6 of the turret. (6) Surfaces *C* and *D* are faced by the tools mounted in the tool-block *M*. (7) Surface *E* is rough-crowned by the cutter *J* mounted on a tool-block connected to the taper attachment. (8) The work is removed from the chuck. Fig. 7 shows a front view of the machine just after the third step in the series has been completed, while Fig. 8 shows a view from the turret end of the machine, taken just prior to the removal of the work from the chuck. The latter illustration gives a clear view of the taper attachment used in machining the crown on the pulley rim.

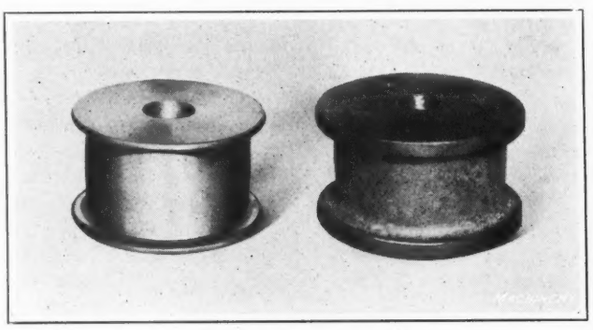


Fig. 9. Appearance of Double-flanged Pulley before and after being machined

Equipment for Machining Double-flanged Pulleys

Fig. 9 shows the appearance of a cast-iron double-flanged pulley before and after being machined on a No. 6 geared friction head turret screw machine. This part is machined in one chucking, the time required for performing the operations being 8 minutes. A dimensioned drawing of the pulley is shown in Fig. 10, while a lay-out of the tooling equipment used to machine this part is shown in Fig. 11. The different steps in this chucking are taken in the following procedure: (1) The work is held in a chuck having special jaws that expand and grip the work along the circumference of the large hole in one side of the pulley. (2) Surface *A* is cut into along surface *F* by cutter *L* and then is rough-turned by this tool,

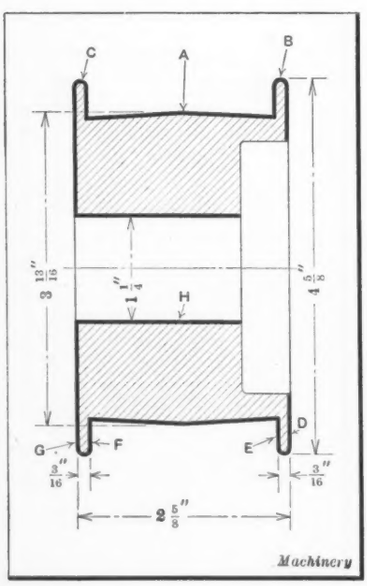


Fig. 10. Drawing of Double-flanged Pulley

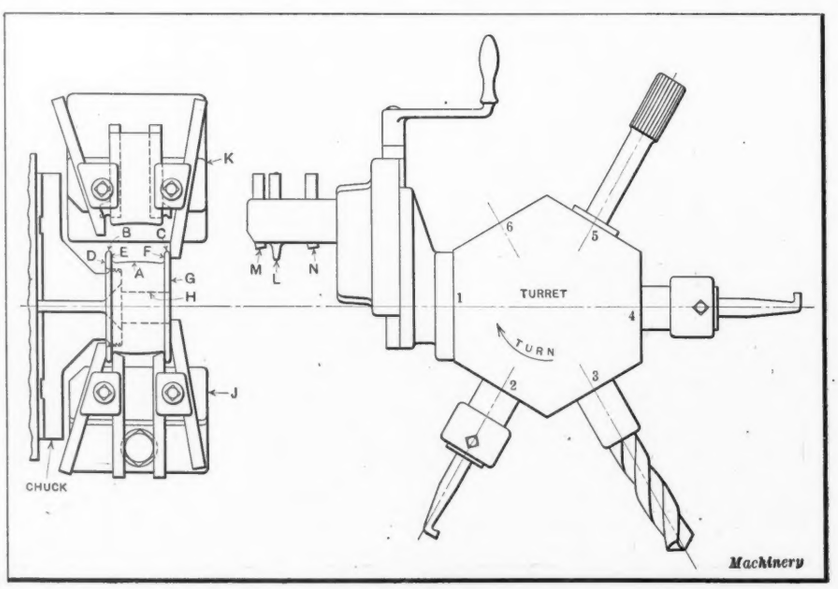


Fig. 11. Tooling Equipment used in finishing Pulley shown in Fig. 10

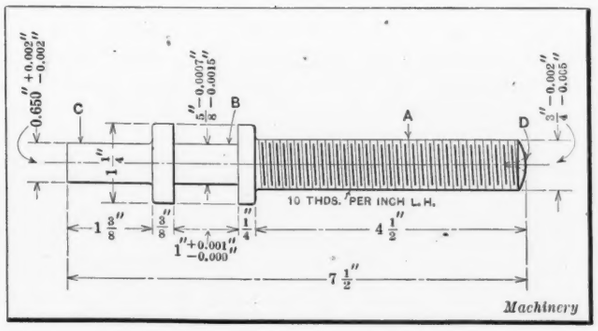


Fig. 12. Dimensioned Drawing of Special Screw

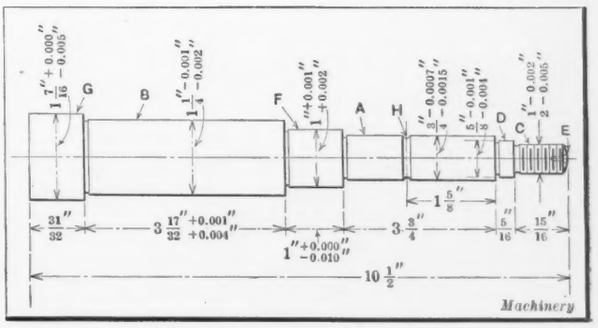


Fig. 13. Pinion-shaft produced from Bar Stock

while surfaces *B* and *C* are rough-turned by cutters *M* and *N*, all of these tools being mounted in the slide tool held in Face 1 of the turret. At the same time, surfaces *D*, *E*, *F*, and *G* are rough-faced with the tools mounted in tool-block *J*. (3) Hole *H* is rough-bored by the cutter held in the adjustable boring cutter holder mounted in Face 2 of the turret. (4) Hole *H* is drilled by a drill mounted in Face 3 of the turret. At the same time surfaces *D* and *G* are finish-faced, surfaces *B* and *C* are rounded, and surface *A* is crowned by the tools mounted in the tool-block *K*. Fig. 18 shows the performance of this step. (5) Hole *H*, Fig. 11, is finish-bored by the cutter held in the adjustable boring cutter holder mounted in Face 4 of the turret. (6) Hole *H* is reamed by the reamer held in Face 5 of the turret. (7) The pulley is removed from the chuck. This finishes the operations on the pulley, leaving it in the condition shown to the left in Fig. 9.

Producing Special Screws from Bar Stock

The special screw illustrated in Fig. 12 is produced from 1¼-inch round steel stock in 5½ minutes on a No. 4 universal turret screw machine. This part is 7½ inches in length over all and has a left-hand thread on one end, the outside diameter of which is ¾ inch. A lay-out of the tooling equipment used in the manufacture of this piece is shown in Fig. 14. The sequence of the various steps in the operation is as follows: (1) The stock is fed to the stop in Face 1 of the turret. (2) Surface *A* is turned by the single cutter turner mounted in Face 2 of the turret. At the same time, surface *B* is formed by cutter *H* which is mounted in a tool-block, and the right-hand end of surface *C* is cut into by cutter *F* which is held in the square turret, preparatory to turning this surface. The square turret is then indexed 90 degrees and surface *C* turned by cutter *E*. (3) End *D* is rounded by the end forming tool held in Face 3 of

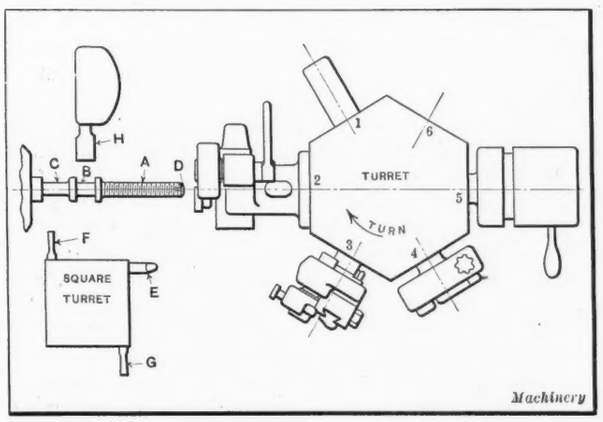


Fig. 14. Lay-out of Tooling Equipment for Special Screws

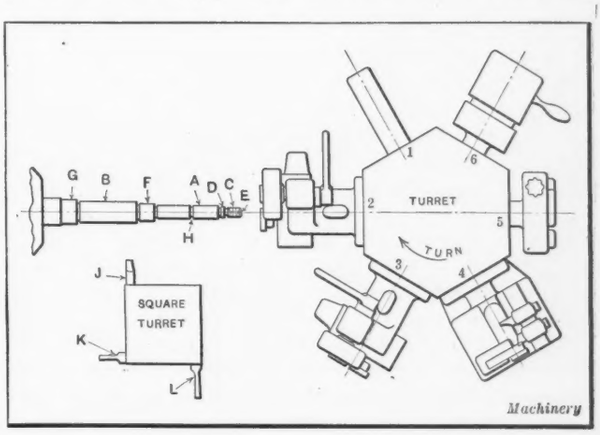


Fig. 15. Tooling Equipment employed in machining the Pinion-shaft

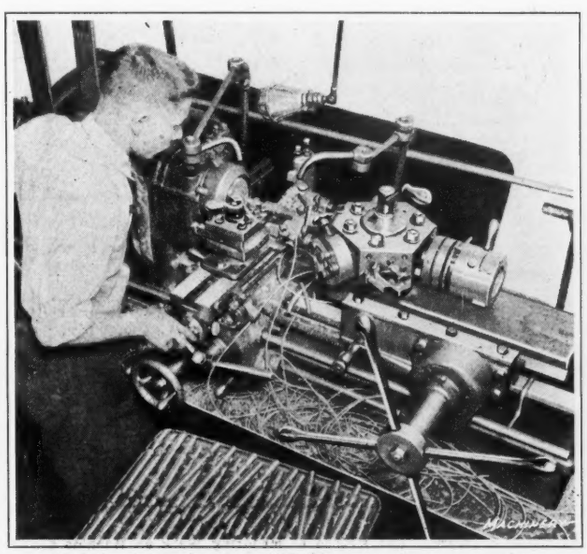


Fig. 16. Second Operation on the Special Screw shown in Fig. 12

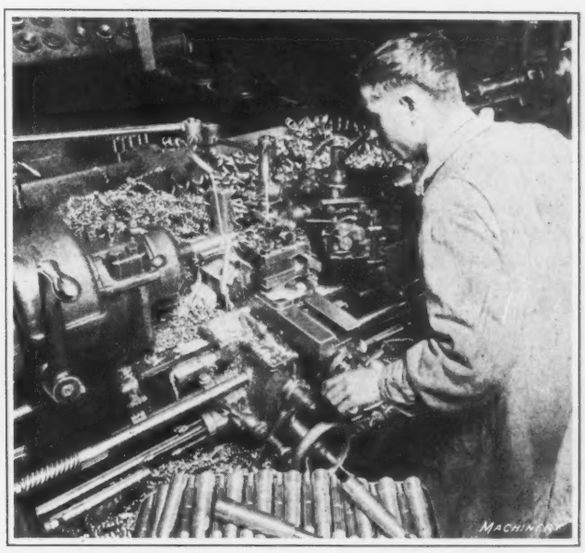


Fig. 17. Machine engaged in the Production of a Pinion-shaft

Fig. 18. Machine engaged in finishing Flanged Pulley

the turret. (4) A center is drilled in end *D* by the centering tool mounted in Face 4 of the turret. (5) Surface *A* is threaded with a set of chasers in the die-head mounted in Face 5 of the turret. (6) The completed piece is cut from the stock by cutter *G* which is held in the square turret. The machine shown in Fig. 16 is engaged in performing the second step in the series.

Tooling Equipment Used in Machining a Pinion-shaft

The pinion-shaft illustrated in Fig. 13 is produced from 1½ inch round steel stock in 10 minutes on a No. 4 universal turret screw machine. The over-all length of this piece is 10½ inches. A lay-out of the tooling equipment required in the production of this part is shown in Fig. 15. The order in which the series of steps in the operation is taken is as follows: (1) The stock is fed to the stop in Face 1 of the turret. (2) Surface *A* is turned and surfaces *C* and *D* are turned to the diameter of surface *A* by the single cutter turner mounted in Face 2 of the turret, while surfaces *B* and *G* are turned by cutter *J* which is held in the square turret. (3) Surface *C* is turned by the single cutter turner mounted in Face 3 of the turret. (4) Surface *D* is turned and end *E* rounded by the cutters held in the multiple cutter turner mounted in Face 4 of the turret. (5) Surface *F* is turned by cutter *J*, and a center is drilled in end *E* by the centering tool held in Face 5 of the turret. (6) The grooves at the various shoulders and oil-groove *H* are cut by cutter *K*, which is mounted in the square turret. (7) Surface *C* is threaded with chasers in the die-head held in Face 6 of the turret. (8) The finished piece is cut from the stock by cutter *L*, held in the square turret. Fig. 17 shows the machine engaged in performing one of the steps in this operation.

* * *

TURNING TOOL OF UNUSUAL DESIGN

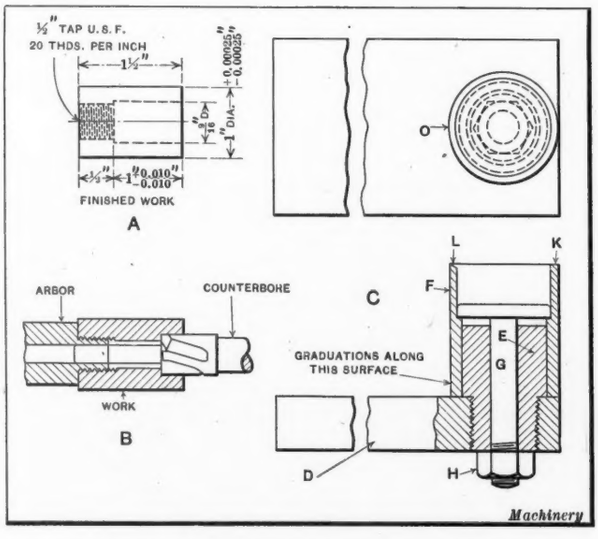
By W. D. FORBES

The writer once accepted a contract to manufacture a large quantity of small machine parts under the impression that the required accuracy could be easily obtained on an automatic screw machine. However, it developed later that greater accuracy than had been anticipated was required in tapping and counterboring the holes concentric with the circumference of the work. Because of these exacting requirements and the small tolerance on the outside diameter of the work, which is shown at *A* in the accompanying illustration, it was found impracticable to machine the pieces according to the original plan. In order to fulfill the terms of the contract without sustaining a loss, it was necessary to have the work produced by unskilled workmen, and this was accomplished by the methods to be described as follows:

The stock was an easy cutting material and was furnished 1/32 inch larger in diameter than the finished work. The hole was drilled and tapped in an automatic screw machine, the hole being drilled somewhat deeper than the length of one piece; then the end of the piece was faced, and the work cut off. The work was mounted on an arbor as shown at *B* for the final operation, which consisted of counterboring the hole and finish-turning the work in a lathe. The arbor was threaded, the threads being made to suit the tapped hole in the work. The arbor was held in the headstock spindle and was also provided with a longitudinal hole that served as a guide for the pilot of the counterbore. A collar was placed on the shank of the counterbore in order to gage the depth of the counterbored hole. The taper shank of the counterbore was held in the tailstock spindle.

The fixture and tool shown at *C* were designed for performing the turning operation. The support *D* was bolted to the compound slide of the lathe by means of T-bolts in the toolpost slot. The plug *E*, which steadies the circular cutting tool *F*, was screwed into this support as shown. The bolt *G* and nut *H* were provided for clamping the tool *F* so that any desired part of the cutting edge of the tool could be brought into contact with the work. The tool was graduated along its lower edge, the divisions being about 1/8 inch apart. One of these graduations was marked *O*, and when the fixture was set up on the machine the tool was turned until this graduation coincided with an index line *O* on the top of the support.

When a skilled machinist had set the tool to the proper height and located it so that the work would be turned to the required size, an apprentice could operate the machine. After the work was counterbored the circular cutting tool just described was fed across the work; then the operator stopped the machine, removed the piece by means of a special wrench, and ran the carriage back by hand, after which he was ready to repeat the operation. It was discovered that about 200 pieces of work could be finished before there was any noticeable wear on the tool. When this occurred, another keen cutting edge was obtained by loosening nut *H* and turning the tool until the next graduated line along its lower edge coincided with the index line on the support. It is apparent that as the locations of the axes of the tool and work remained unchanged during this adjustment, the size of the work finished by the readjusted tool would be the same as that of the work finished by the tool prior to the adjustment. Cutting tools of this type could be adapted for many turning jobs where it would not be required to work close to a shoulder. When used for cutting brass or similar metals, the edge of the tool can be left at right angles with the side as illustrated at *K*, but when used for cutting steel, the edge must be beveled on the inner side as shown at *L*.



(A) Detail of Work. (B) Method of mounting Work on Machine for Counterboring Operation. (C) Circular Tool and Fixture used for Different Metals

Patterns as Foundry Tools

By JABEZ NALL

IN designing patterns there are a number of essential factors requiring consideration that do not enter into the actual construction of the pattern. For instance, the action of the various metals and their contraction may affect various sections of the same casting differently, requiring special treatment of or allowances in these parts. The action of the metal contracting will affect some castings, in which the metal is of varying thickness, so as to warp or distort them. This distortion can sometimes be avoided in the foundry, or it may be prevented in the pattern shop by cambering the pattern. If, however, the arrangement of the pattern is such that this is impossible owing to the inaccessibility of the parts affected, the cause of the trouble may be attributed to a poorly designed pattern.

The action of the metal in making steel castings differs from the action of the metal in making gray iron castings, and the practice in the two types of foundries is therefore different. In molding gray iron, for instance, the molder can insure a solid casting by keeping the feeding head, or riser open by churning and by adding molten metal from time to time to fill the space caused by contraction as the metal congeals and the casting becomes set. When molding steel castings, the metal congeals so quickly that it is not possible to do this, and a sufficient head pressure must be provided to insure solidity and to furnish a body from which the casting can draw the metal required to fill the space caused by contraction. In steel castings this space is about double that in iron castings. If the metal is thin at the cope side of the casting, the feeding head, in order to be effective, must be of liberal proportions so that the metal will not congeal too quickly, or in shop parlance, "freeze." A sufficient thickness of metal must be added at this place to permit the feeding of the heavy metal below.

A case in point is illustrated in Fig. 1 which shows the base of a bulldozer frame casting, the metal of which is quite thin compared with that in the drag side of the casting. The head at *A* has been entirely removed by an electric arc, but all the metal below the head has been left so as to connect with the heavy metal in the bearing at *B*, where it is essential that the casting be solid. It will be noticed that the other heads have not as yet been removed. This illustration emphasizes the fact that a thorough knowledge of what is required in the foundry is essential in making patterns. To satisfy these requirements it may be necessary to depart from the non-essential details of the design.

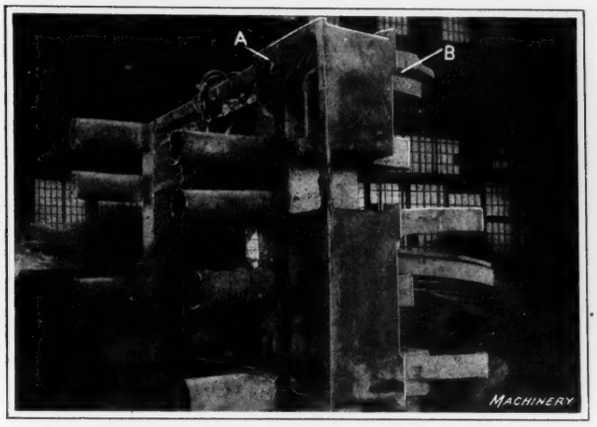


Fig. 1. Base of Bulldozer Frame Casting, showing Location of Feeding Heads

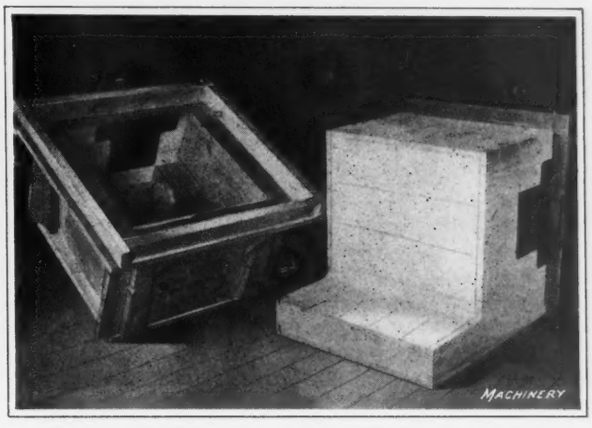


Fig. 2. Pattern and Core-box used in producing a Slide Casting from Cast Iron

How Different Metals Affect the Design of the Pattern

The simple form of pattern shown in Fig. 3 will serve to illustrate the fact that a pattern may be properly designed for use in producing castings of some one particular metal and at the same time be altogether unsuitable when used to produce castings from some other metal. The illustration represents a form of clamp, having three bosses, one at each end and one at the center. The central boss is for a clamping or binding screw. As a reinforcement, the top of the casting is arched as shown. According to common practice, most patternmakers, if given this pattern to make, would immediately plan on providing a split pattern, parted on the center line *CC*. This would be entirely proper if the casting were to be made of iron, but if it should be a steel casting, this method would not be the best one to follow. The reason for this is that in order to get a solid steel casting the molder must place feeding heads at each of the three high spots *A*. These heads must afterward be removed and the surfaces where they formerly joined the casting must be smoothed, thus adding considerably to the cost of finishing the casting.

If, however, this pattern were made in one piece and if it were molded in such a position that the crown of the arch would become the high point in the mold, one large head placed at point *B* would be sufficient to insure a solid casting. In such a case the head should be placed so that it may be conveniently and cleanly removed by the use of an oxy-acetylene flame. This makes a stronger pattern, with which a casting can be more quickly molded and which will produce a better job in every respect. If many castings are to be made, a sand-match or a follow-board should be provided. A pattern made to mold in this way may also be used in the same manner and with equal success when cast iron is used.

Another case which illustrates the fact that the construction of the pattern should be governed by the metal being molded is shown in Fig. 4. It will be noticed that the front walls are rather light compared with the metal in the rear part of the casting. These castings were originally made from cast iron, the pattern being arranged as indicated in Fig. 2 with an overhanging core-print for setting the core. This method gave excellent results both in molding and in the quality of the castings produced. The overhanging print allowed the core to act as a covering core, so that the cope half of the mold was not necessary, thus reducing the molding cost. The mold was made on a jarring machine.

This same pattern proved a failure when it was later used as a tool to produce steel castings owing to the fact that steel, when molten, congeals much more quickly than iron. Consequently, imperfect castings were produced, caused by feeding the heavy sections of metal through the lighter sections. When drilling the holes shown in the illustration of the casting, Fig. 4, the drill would invariably run into shrink holes, or into defective metal, thus making it difficult to obtain a perfect bore and often resulting in the breakage of drills. As the pattern was made to mold in the manner referred to, the most economical remedy seemed to be to change the pattern to allow it to be molded on the side as shown in Fig. 4, and to extend the core-print as shown in broken outline, so as to furnish a better guide and balance for the core in the mold. The molder was then able to place one or more feeding heads directly above the heavy parts of the casting, thus obtaining enough pressure and sufficient metal to draw upon to insure a solid casting throughout. This change eliminated the entire trouble.

Factors of Strength and Contraction in Pattern Construction

When considering how best to arrange a pattern for any given job, the patternmaker is confronted with the fact that there are usually several ways of doing the job, and the selection of the proper method depends upon his knowledge of foundry methods. In this connection, there are a number of factors to be considered, one of which is the construction of the pattern so that it will retain its shape and be strong enough to insure a long life under the hard usage which it is sure to receive in the foundry. This usage is particularly severe in steel foundries where the sand is rammed much harder than it is in iron foundries. It is also very important, particularly in molding large work, to provide means for withdrawing the pattern from the sand and also to make the pattern itself rigid enough to withstand the pulling power of a large crane.

The amount of pull that a heavy pattern must withstand is well brought out by a recent experience of the writer when making castings from a large pattern, approximately 17 feet long and 58 inches deep. This pattern was of a shape that made it difficult to build for strength, although it seemed strong enough when completed. Following the usual procedure, machine-steel lifting straps were employed to withdraw the pattern from the mold. These were made about 3 feet long and were hooked into and bolted to the inner framework of the pattern. The pattern was used successfully in making the first two castings, but in making the third mold, either the same care was not taken in starting the draw, or on account of the hot, damp sand of the foundry floor, or for some other unknown reason, the pattern stuck in the mold. The pull from the 50-ton crane used in removing patterns from the mold was so great that two of the lifting straps were pulled out and the parts of the frame to which they were bolted were torn away from the lower part of the frame. After much difficulty, the pattern was finally

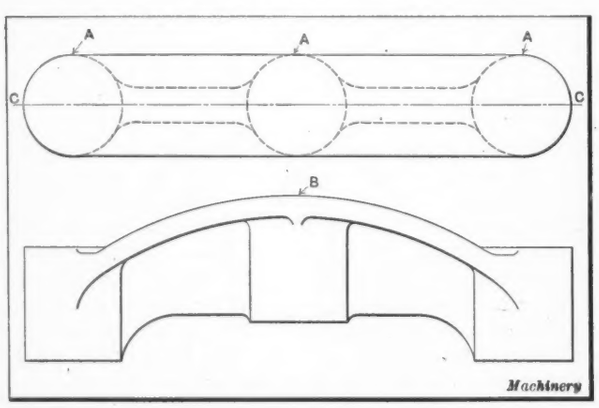


Fig. 3. Pattern used to illustrate Molding Methods for Different Metals

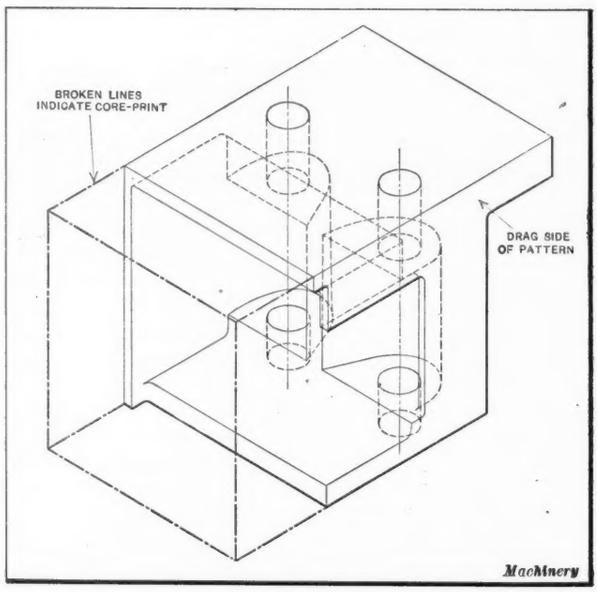


Fig. 4. Slide Casting made from Pattern illustrated in Fig. 2 showing Core-print as arranged to produce Steel Castings

removed—badly damaged—but the mold was not destroyed. The cause for this failure was that the amount of suction at the bottom of the mold was underestimated. Another considerable factor was that of friction on the sides of the pattern, although sufficient draft had been provided. The trouble was remedied by carrying the lifting straps to the full depth of the pattern, hooking and bolting them to the under side of the lower edge of the framework, so that it could not be pulled apart.

The difference in the allowance to be made for the contraction of various metals, as previously stated, is an important point to be considered. For castings of ordinary size and for small sized castings, this difference is not great and the standard shrinkage may be allowed with good results; but on account of the many and varied designs of castings, this factor of contraction affects various castings in different ways. It is not sufficient, for instance, to state definitely that the shrinkage allowance for steel castings should be 3/16 inch to the foot and apply that rule to all steel castings, because practical experience has taught that many castings do not contract uniformly and that some sections of the castings may contract less and certain other sections even more than the standard rule for the material of which the casting is made. Large sized steel castings which require many cores in molding will not contract the standard amount, and it is the experience of the writer that about one-half the accepted allowance, or 1/10 inch to the foot, is approximately correct for this material under these conditions

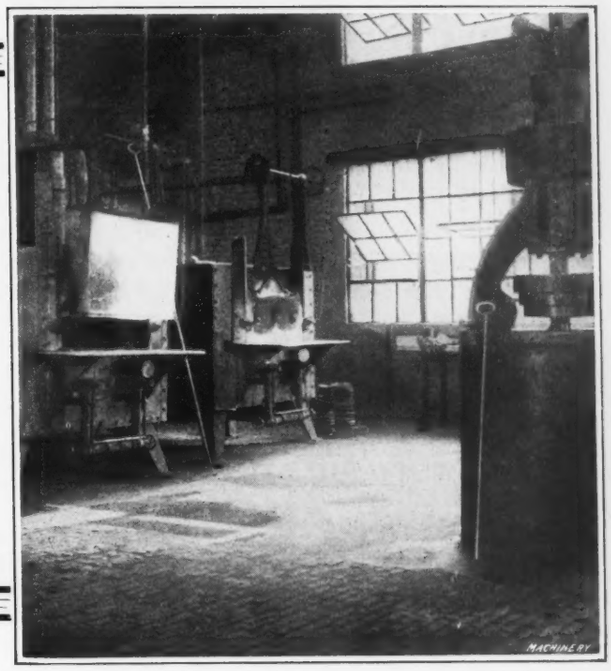
* * *

As the rolling stock on most European railroads is in a worn-out condition, and the demands on the plants in Europe building locomotives and railroad cars are heavier than the capacity available, it is evident that there must be an opportunity for a considerable export trade from the United States, especially in locomotives, but also in railway cars, if American builders could obtain large enough orders to warrant equipping for the type of railway cars used in Europe. The rapid revival of Belgian industry and trade make necessary additional railway facilities in that country, and as neither Germany nor France are able to meet their own requirements in the building of railway equipment, orders for locomotives have been placed in the United States and England. Freight cars, so far, have been bought chiefly from Great Britain. At the time of the armistice, 932 miles of Belgian railways had been destroyed, but practically all of these have now been replaced, which is a remarkable record, considering the difficulties to be overcome.

Carburizing and Casehardening

Methods of Treating Steel after Carburization, Tempering Practices, Packhardening, and Other Methods of Hardening—Third Installment of a Series

By S. P. ROCKWELL
Metallurgist, Weekes-Hoffman Co., Syracuse, N. Y.



THERE are really only four methods of treating work after it has been carburized; these are as follows: (1) Pot quenching, which consists of a single quench from the carburizing pot at or near the carburizing temperature. (2) Pot cooling and single quenching, consisting of cooling the carburized work in the pot and quenching slightly above the hardening or critical temperature of the case. (3) Pot quenching and single cooling, consisting of a single quench from the pot at or near the temperature of carburization, followed by a quenching from slightly above the hardening or critical temperature of the case. (4) Pot cooling and double quenching, which consists of cooling the carburized work in the pot, quenching slightly above the toughening or critical temperature of the core, and again quenching slightly above the hardening or critical temperature of the case.

First Method of Heat-treatment

Casehardening was first accomplished by wrapping pieces of steel, roughly cut into files and tools, in the skin of an animal, together with horn and bone. This was laid in the fire and heated to a red heat after which the steel was removed and quenched, thus obtaining surface hardness. This method corresponds to the present direct quenching from the pot. When small parts such as screws and nuts are quenched from the pot they are usually dumped into a sieve so that the carburizing material can be screened off, after which the work is put into water or oil. As previously mentioned, sometimes the entire contents of the pot are dumped together into the water or oil, and the work is separated from the carburizing material. After this material is removed from the quenching bath it is dried for future use or perhaps thrown away. This method of heat-treatment leaves the case in a hard but extremely brittle condition, unrefined and coarsely crystalline, while the core is only partially refined and coarse in texture. The work in this condition has no great toughness or resistance to shock, and the best that can be said of it is that it is merely hard. Large pieces, such as wrenches, gages, etc., which due to riddling or rough handling may warp out of shape, are removed from the pot by wires attached to them or by tongs, and quenched separately. Hardness and strength conditions are not changed by this method, even with a drop in temperature before quenching, for the reason that the grain has been set by the highest temperature and the work must cool below the red stage and be reheated in order to cause appreciable diminution of the grain size. Further than this, a condition of liquation or enfoliation takes place, which is a lack of cohesion between the case and the core. On work hardened in this way which must withstand wear or shock there will be a tendency for the case to chip or flake from the core. This tendency commences with a certain degree of carburizing temperature and increases with higher temperatures.

Second Method of Heat-treatment

By cooling in the pot and rehardening at from 1400 to 1450 degrees F., the structure of the case will be refined, giving maximum hardness with maximum toughness. The core structure, however, will not be refined and in consequence the core will not have the maximum toughness of which it is capable. Danger of enfoliation will also be great. This method is widely used and gives excellent results for a multitude of parts such as bearings, camshafts, arbors, gages, etc. Parts treated in this way are less liable to warp, as the hardening treatment is given at a low temperature and the shock of coming in contact with the quenching medium is not so great as when quenched at higher temperatures.

Third Method of Heat-treatment

Quenching from the pot and again rehardening at a temperature of from 1400 to 1450 degrees F. will serve the purpose of refining the case to a great extent and will likewise bring out the natural qualities and toughness of the initial steel or core. The rehardening will not disturb the core conditions secured in the first quenching operation, but will refine the case and give maximum hardness with the toughness. This treatment causes the case and core to unite more and form a less abrupt line of transition so that enfoliation is only slightly in evidence.

Fourth Method of Heat-treatment

Cooling in the pot, rehardening at about the critical temperature of the core, and quenching (the critical temperature being from about 1550 to 1650 degrees F., depending upon the original carbon content of the steel), and rehardening at the critical temperature of the case (1400 to 1450 degrees F.) will serve to refine the core and case to the maximum extent. The result will be maximum toughness and grain refinement of core, and maximum toughness, grain refinement, and hardness of the case. The function of cooling in the pot is to allow the structure of the steel to come to rest, which helps to prevent warpage from internal strains. This

treatment tends to make more uniform work, especially with regard to the core, than pot quenched work, as the first quenching is apt to be controlled closer than a quenching from the pot. It also adds slightly to the depth of the carburization; saves carburizing material from exposure to the air; saves a slight scaling on the inside of the pot; and avoids subjecting the workman to excessive temperature. Such treatment also decreases the danger of enfoliation to a minimum.

Relative Qualities of Oil and Water for Quenching

Water or oil can be used for any of the quenchings. Screws, nuts, and other small uniformly shaped parts requiring more hardness are usually dumped into water. Intricate and delicate parts which are liable to warp or crack should be quenched in oil in order to obtain core refinement. Where the single pot quench only is desired, it will be found that there will be no appreciable loss in the hardness of the case by using oil instead of water. Extremely delicate parts may be floor-quenched, that is, laid on the floor to cool to obtain partial core refinement. In quenching to obtain case refinement, there is less danger of warpage due to a lower temperature; still certain shapes will warp excessively and sometimes fixtures must be used to hold the parts in shape. Oil-quenching will cause very little warpage, but it will be found that the hardness of the case will not be so great when oil is used as when water is used. The hardness will decrease as the cross-section of the work increases, approximately according to the following table, which gives the readings on the scleroscope:

Hardness Reading on Scleroscope

Area of Cross-section, Sq. Inches	Water-quenched	Oil-quenched
0.5	90	85
1	86	78
2	83	70

Owing to the difference in time required to cool the work by quenching in water and oil, it is necessary to start to quench in oil at a temperature about 25 degrees F. higher than is necessary when quenching in water, in order to approximate the same refinement of grain in the case. The chart shown in Fig. 10 depicts graphically the relation of the grain size of the original steel to the grain size of the case and core when treated according to the four treatments outlined.

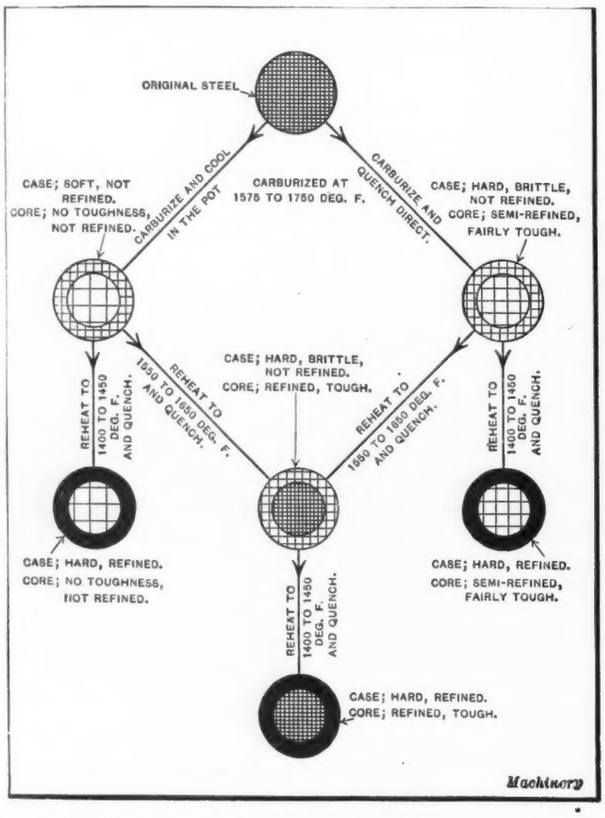

ORIGINAL STEEL
CARBURIZED AT 1575 TO 1750 DEG. F.
CARBURIZE AND COOL IN THE POT
CARBURIZE AND QUENCH DIRECT
CASE; SOFT, NOT REFINED. CORE; NO TOUGHNESS, NOT REFINED.
CASE; HARD, BRITTLE, NOT REFINED. CORE; SEMI-REFINED, FAIRLY TOUGH.
CASE; HARD, BRITTLE, NOT REFINED. CORE; REFINED, TOUGH.
REHEAT TO 1400 TO 1450 DEG. F. AND QUENCH.
REHEAT TO 1550 TO 1650 DEG. F. AND QUENCH.
REHEAT TO 1650 TO 1850 DEG. F. AND QUENCH.
REHEAT TO 1400 TO 1450 DEG. F. AND QUENCH.
CASE; HARD, REFINED. CORE; NO TOUGHNESS, NOT REFINED.
CASE; HARD, REFINED. CORE; SEMI-REFINED, FAIRLY TOUGH.
REHEAT TO 1400 TO 1450 DEG. F. AND QUENCH.
CASE; HARD, REFINED. CORE; REFINED, TOUGH.
Machinery

Fig. 10 Diagram showing Relative Grain Size of Work after Each Method of Heat-treatment

Tempering

Tempering, the process of drawing back or relieving strains, consists of simply reheating the hardened work to medium temperatures, and quenching, thus toughening the work and eliminating the danger of cracks and breakages at the expense of the initial hardness gained by quenching. There are three ways of determining when the work has reached the correct tempering temperature which are as follows; first, by maintaining the bath in which the work is immersed at the desired temperature; second, by sprinkling chemicals or metals on the work, the flash and melting points of which are known; and third, by heating the work and watching the colors.

Water can be used for tempering up to 212 degrees F. only, but by adding salts, such as calcium chloride, this temperature can be increased to some extent. Immersion of the work in oil baths is the most common form of tempering when the temperature does not exceed 600 degrees F., but there are a number of special and stock oils whose flash point is slightly over 600 degrees F., which may be used with absolute safety. For higher temperatures, niter baths, sometimes made of 50 per cent sodium nitrate and 50 per cent sodium nitrite are used. This mixture melts at about 500 degrees F. and can readily be used for temperatures as high as 1200 degrees F.

Open-fired furnaces of various designs are often used for tempering, and in this case, the work is piled up in the furnaces in racks or trays. The heat is controlled by a pyrometer system, and the work is allowed to remain in the furnace until entirely heated through. Such tempering is used on heavy railway springs, shells, gun barrels, etc. The tempering of articles by immersing them in oil of known flash and fire points and reheating until the oil starts to burn, is a method used on springs and small articles where no degree of precision is required. This method imparts a black finish to the article. On gun parts where it is desired to have this black finish uniform, sand and oil are used to temper the work by heating it over a flame in a hopper open at the top until the oil is burned off.

Some hardeners sprinkle salt, sawdust, lead filings, etc. on the work as they are heating it, to determine the degree of heat which it has reached. Tempering in a lead pot is a method often used, as lead has a wide range of temperature in the molten condition and its heating can be closely controlled. This method is used for springs requiring close control.

Color tempering consists of heating the work slowly and watching the colors as they appear on portions of the work previously polished. The tempering colors are a very good guide in determining the temperature of the work, provided the work is heated slowly so that there is no perceptible lag from the outside to the inside and the carbon content of the work does not vary more than 30 per cent. Mercury thermometers are in general use for temperatures up to 700 degrees F., but for higher temperatures, electric pyrometers are customarily used, although heat indicators based on the expansion of the metal are sometimes found satisfactory. Salt or niter baths leave a coating of the salt on the work, but immersion in water will remove this coating, after which the work can be dried in sawdust or air. The salts may be saved by evaporation of the water if it is thought expedient.

Removal of Oil from Work after Oil-tempering

Oil tempering baths, as a rule, cause considerable trouble because the heavy oil which is used for this purpose adheres to the work, especially in small holes, etc. Some users dip the oily work into kerosene to remove the heavy oil and then dump it in sawdust. The work may be dipped in a solu-

tion of sal soda, tri-sodium phosphate, or other prepared compounds, in order to remove the oil, after which it is given a final rinsing in water. A homemade oil-tempering furnace, and hot soda and water cleaning vats are shown in Fig. 11. Compressed air is used to stir the oil and keep it from charring in the bottom of the tank. The tilted runway is a drain to allow dripping oil to run back into the tempering tank. The two tanks seen at the right contain alkali cleanser and water. After tempering and draining the work, it is dipped into the alkali and then into the hot water, from which it emerges free from oil.

The flash point of heavy tempering oils is usually about 600 degrees F., while the majority of carburized work is tempered at from 300 to 450 degrees F. which leaves a large margin of safety. There are a number of thin body oils with flash points around 500 degrees F. which can be mixed with heavy tempering oils, thus producing an oil which will not stick to the work excessively and yet which will not have a dangerously low flash point.

When dipping the work in the soda solution to remove the tempering oil, if the work is dipped quickly after the tempering and the solution is kept hot to the point of boiling, the work will not be hardened appreciably by this quenching effect, and the soda will remove the tempering oil very much quicker. Scum is eventually formed on the surface of the solution by the excessive tempering oil, and this scum should be removed by skimming with a board or by laying a newspaper on the surface, which acts as a blotter.

Table 5 shows, in scleroscope and Brinell units, the relative hardness of carburized steel, subjected to different tempering temperatures after the work had been hardened at a temperature of 1450 degrees F. by quenching in oil. This table cannot be relied upon absolutely, but it can be used as a basis on which to figure the depth of case and the percentage or concentration of carbon that will affect the depth of case. The steel from which this test was made showed 1.08 per cent carbon in a depth of 0.010 inch.

Fig. 11. Oil-tempering Furnace, and Soda and Water Cleaning Vats

In MACHINERY'S HANDBOOK, page 1139, there is a table which gives the color of the steel at various tempering temperatures, and also at high temperatures. By referring to this table, it will be noted that no change in color is visible for temperatures between 570 and 752 degrees F. Table 6 shows a list of the tempering colors and temperatures which are used by a certain concern for tempering various tools and parts. These temperatures can be used as a guide for all cases except where high-speed steel is used.

Pack-hardening

Pack-hardening as usually conducted is actually carburizing, the only departure from the process, in general, being that the temperatures of the heats are lower. Correctly speaking, pack-hardening is the process whereby high-carbon steels or steels that will harden without the aid of carbon added by carburizing may be protected from furnace gases and air. By packing in some carbonaceous material, the work is protected by the carbon gases given off, and in quenching from the pot, the work is clean and free from scale. A valuable point in favor of this operation is that the work is brought to the quenching temperature slowly and uniformly, and so dangers of cracking and warpage are reduced to a minimum. Any carburizer can be employed in packing, used material being the best, as the carbon strength of the gas is lower and there is less danger of carburizing the work. The danger of decarburizing is slight, provided the lowest temperature that can be used for hardening the work is employed. The length of time of the operation has a tendency to increase the grain size, which is augmented by high temperatures. It is dangerous to carburize the surface of high-carbon steel, because a line of demarcation between the case thus produced and the case of the original steel will shorten the life of the part. Minute surface cracks usually develop after hardening.

In a certain instance, trouble was experienced in securing a surface free from soft spots on gage disks of high-carbon steel, so a heat-treatment was used with no better results. The hardness test was very severe, as the tool-room foreman drew a diamond wheel dresser over the surface under severe pressure. Pack-hardening was attempted, and at first the gages were packed in fairly fresh carburizer and put in a furnace having a temperature of 1700 degrees F., with other low-carbon work being carburized. After quenching, the work was found to satisfy the hardness requirements and was then accepted for grinding and lapping. The grinding was done with utmost care on a wet wheel. During the lapping operation small cracks began to appear on all the work, causing it to be condemned. Success was eventually attained by heating the work at a temperature of about 1425 degrees F. Pack-hardening of low-carbon steel is a misnomer, because what is done is really carburizing.

Common hard wood charcoal perhaps answers best the requirements for pack-hardening, especially if it has had an initial heating to eliminate shrinkage and discharge its more impure gases. The work is packed as in carburizing and in the same type of receptacle. A wire attached to each piece and brought up in a loop to the under side of the cover allows the work to be removed easily. By carefully fastening these wires to the work, each piece can be quenched in relation to its axis so as to reduce quenching warpage to a minimum. Bone is often used for this work, but as it is so active in its carburizing properties at low heats, it is usually advisable to mix it with charcoal.

Work Coloring Process

Work is not colored so much now as formerly; however, certain classes of tools, nuts, and bolts are treated this way. Work so treated has been thought to be superior to other work and it has also been considered rustproof. The superiority of work treated in this manner is mainly in the pleasing effect that it gives, as no improved physical properties are attached to this method, and the work will rust nearly as readily as uncolored but hardened work. The

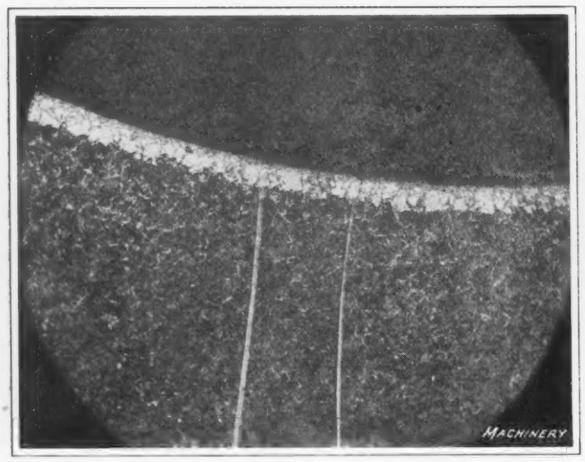


Fig. 12. Photomicrograph of 0.4 per cent Carbon Steel after being immersed in Cyanide and quenched in Oil. White Surface is Zone of High Carbon Content

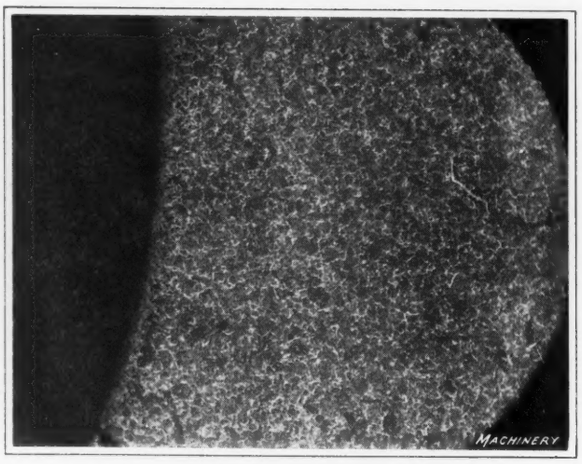


Fig. 13. Photomicrograph of 0.4 per cent Carbon Steel after being pack-hardened in Bone and Charcoal, cooled in the Pot, and rehardened in Lead

coloring is an indication that the work has received heat-treatment.

The method of coloring is to pack the work, which has previously been polished and cleaned so that there is no grease or finger marks on it, in charcoal, bone, or a mixture of the two; heat as in carburizing to from 1475 to 1550 degrees F.; hold at this temperature so that the desired depth of case is obtained; remove the pot from the furnace, throw off the cover, and hold the pot just above the water quenching tank; turn it over quickly and let the entire contents fall into the water. If a sieve has first been placed in the quenching tank, the packing medium will fall through it, but the work will be caught and there will be no danger of soft spots. The colors are heightened by having air bubbling up through the water tank. The colors obtained are merely air tempering colors resulting from oxidation on bright steel, and the same colors may be produced by slowly heating polished steel, but the beautiful mottled effect will be missing, as the surface oxidation is more uniform. The vividness of the colors can be enhanced by adding leather and cyanide to the bone and charcoal. After a little practice, beautiful results can be obtained. The colors can be brought out more vividly by rubbing the work with oil before it is cold.

Pack-hardening High-speed Steels

The pack-hardening of high-speed steels is extensively done. There are many tools which are so delicate and have such a variation in cross-section that only with extreme care can they be hardened in the open furnace and preserve the delicate edges and corners. Other high-speed tools which cannot be ground after hardening or economically lapped are successfully pack-hardened. The best method that the writer has used for this purpose is as follows: The iron pot of a lead pot furnace was replaced by a black-lead crucible, only about 2 inches larger in diameter than the largest dimension of the work to be hardened. The crucible was filled with finely ground hard wood charcoal and heated. As the charcoal shrunk, new material was added until the shrinkage was materially reduced. In the meantime, the work was wired for easy removal from the crucible and in some cases preheated to from 900 to 1000 degrees F. The furnace was then shut off and the charcoal removed from the crucible to within 2 inches of the bottom. The work was then placed in the crucible and a fire end attached to a pyrometer was placed next to it. The still hot charcoal was poured back into the pot and the furnace was started. The pyrometer was watched so that the rate of heating was uniform and when the temperature indicated was 2000 degrees F., the furnace fuel supply was reduced slightly. The indicated temperature increased to about 2200 degrees F. in from fifteen to twenty-five minutes. The wires to which the work was attached were then grasped with tongs, the work removed and quenched in oil.

Work handled in this manner has undoubtedly had the original surface carbon content increased. The core, however, has received the full benefit of the correct heat, which helps to eliminate this disadvantage. High-speed steels so treated make better finishing tools, and at the same time retain the heat-resisting qualities of high-speed steel. However, high-speed steel is not intended for use as a finishing steel but for heavy-duty work, and so it is advisable to heat in a muffle furnace when possible. The largest makers of high-speed tools do this and the cost of this steel warrants the greatest care in this operation.

There are several pack-hardening preparations on the market which sell because the average hardener is unfamiliar with the steel. One compound composed of non-shrinking petroleum, coke, and carbonaceous materials is used for packing the work. A heat of 1750 degrees F. is used, after which the work is either quenched direct or cooled in the pot, and rehardened at 1450 degrees F. The work becomes hard on the surface, but the core remains soft. High-speed steels do not depend on carbon for their hardening and heat-resisting power but on other elements, particularly tungsten. High-speed steel treated as described in the foregoing is no better than a good grade of tool steel and is little better than carburized low-carbon chromium steel. High-speed steel properly hardened should never be glass-hard, as toughness, and heat- and shock-resisting qualities are the properties required. It has been determined that from 1000 to 1150 degrees F. are the best tempering temperatures to use, depending on the chemical composition.

TABLE 5. RELATIVE HARDNESS, IN SCLEROSCOPE AND BRINELL UNITS, OF CARBURIZED STEEL TEMPERED AT VARIOUS TEMPERATURES

Tempering Temperatures		Instrument Readings	
Degrees Fahrenheit	Degrees Centigrade	Scleroscope	Brinell
0	0	86	675
300	148.9	86	675
400	204.4	85	650
500	260.0	83	580
600	315.6	79	530
700	371.1	75	480
800	426.7	71	430
900	482.2	67	360
1000	537.8	60	290

Machinery

Cyanide Hardening

The use of cyanide for hardening is not a casehardening or carburizing process, but it is, in a way, analogous to pack-hardening. When work is immersed in heated cyanide, it is protected from air oxidation, and the cyanide imparts carbon to the surface. Cyanide hardening is used for several purposes, some of which are as follows: to harden low-carbon steel by giving it a

hard surface, which is applicable to set-screws, and light snap and plug gages where depth of hardness is not of great importance but where a very shallow or surface hardness is required; to harden medium carbon steel, when the parts made from it must combine the available toughness of this class of steel and a surface hardness; to harden tool steel to prevent finished ground parts from scaling and to diminish the danger of soft spots; and to harden carburized work, which through previous hardening by other methods, has developed soft surface spots.

This shallow hardened surface is found to be extremely high in carbon, being much higher than is obtained by the carburizing process under ordinary commercial conditions. For this reason it is possible to use low temperatures and obtain the desired surface hardness. By the use of too low a temperature in hardening tool steel, it may be found with a test file that the work is hard but the steel directly underneath the surface will be soft; this applies to carburized work. By the use of too low a temperature with a medium-carbon steel, the steel under the hard surface may not have obtained the required or possible physical qualities. By the use of a low temperature on low-carbon steels, no harm results, provided the surface hardness conditions are met. It is therefore desirable to heat the steel at a temperature called for by the steel itself and ignore the hardening temperature of the cyanide case. This, however, does not apply to low-carbon steels as a general rule, for the reason that the critical temperatures of such steels are high and at such temperatures cyanide boils, gasifies or volatilizes rapidly and in consequence is very wasteful. Temperatures of over 1500 degrees F. are seldom used for cyanide.

The surface hardness depth obtained with cyanide is never great, being rarely over 0.015 inch. The carbon absorption by the surface is unlike that when using the solid carburizing material in that its initial depth of carbon is given to the steel in a very short space of time, and this initial depth immediately chokes off further penetration. Longer exposures to cyanide will only deepen the case a little. Long exposure to the cyanide will also cause the carbon to intensify on the surface to the extreme, thus leaving the work in a condition of intense surface hardness and brittleness with an abrupt line of demarcation between this case and the original steel. This condition often impairs the results desired because surface cracks start easily and erratic shock-resisting qualities are obtained. Cyanide furnaces are merely lead pot furnaces where the lead is replaced by cyanide salts.

Properties of Cyanide

Cyanide is a deadly poison, and where large quantities are used it is best to have a hood over the furnaces to carry off the fumes. When the furnace is used for only a short time, there is little or no danger to the workman unless he is careless and deliberately breathes the fumes. The fumes of cyanide cause sneezing, and in this way the workman is warned of their presence. Care should be taken not to get it under the finger nails, as the fingers may be put in the mouth, and care should also be taken to expectorate if the cyanide spatters and gets on the tongue. Cases where men have been killed or injured by the poisonous effects of cyanide when used for heat-treating steel are extremely rare.

Cyanide, for hardening purposes, is in the form of cyanogen gas held in solution by a salt, either potassium cyanide or sodium cyanide. The former is very expensive and at present is not always available. A great many surface hardening salts are on the market intended to replace cyanide, but they are merely dilutions of cyanide salts with barium, saltpeter, common salt, etc. They sometimes have the advantage

TABLE 6. TEMPERING TEMPERATURE FOR VARIOUS TOOLS AND PARTS, AND COLOR OF METAL AT DIFFERENT TEMPERATURES

Tool	Color of Metal	Temperature in Deg. F.	Tool	Color of Metal	Temperature in Deg. F.
Augers	Light purple	530	Gimlets	Dark purple	550
Axes	Dark purple	550	Hacksaws	Dark purple	550
Bits, half round	Straw yellow	460	Hammers and drop-forge dies	Spotted red brown	510
Bone, cutting tools	Very pale yellow	430	Hammer faces	Very pale yellow	430
Boring-cutters	Straw yellow	460	Hand plane irons	Brown yellow	500
Butt-mills for brass	Very light yellow	420	Hand reamers	Straw yellow	460
Cams with sharp corners	Very dark blue	601	Hand springs	Purple blue	530
Chasers	Straw yellow	460	Hand taps and dies	Straw yellow	460
Chisels, cold, for cast iron	Dark purple	550	Hand tools	Light yellow	440
Chisels, cold for steel	Light purple	530	Ivory cutting tools	Very pale yellow	530
Chisels, cold for wrought iron	Light purple	530	Jaw pieces	Purple blue	530
Chisels, firmer	Dark purple	550	Lathe tools for brass	Very light yellow	420
Chisels for wood	Very dark blue	601	Mandrels, drawing	Very light yellow	420
Chuck jaws	Spotted red brown	510	Milling cutters	Straw yellow	460
Clutch bolts	Very dark blue	601	Milling cutters for brass	Very light yellow	420
Clutch springs	Blue	549	Milling cutters, small	Straw yellow	460
Collets	Dark yellow	490	Molding and planing tools	Dark purple	550
Coppersmiths' Tools	Light purple	530	Needles	Dark purple	550
Cutters, edging	Light purple	530	Paper cutters	Very pale yellow	430
Cutting tools for iron	Light yellow	440	Parts subject to shock	Very dark blue	601
Cutting tools for soft materials	Very light yellow	420	Penknives	Straw yellow	460
Dental and surgical instruments	Light purple	530	Percussion tools for metals	Blue	549
Dies, bending and forming	Dark yellow	490	Planer tools for iron	Straw yellow	460
Dies, embossing	Light yellow	440	Planer tools for steel	Very pale yellow	430
Dies, large cutting	Straw yellow	460	Reamers	Straw yellow	460
Dies, large, forging, for presses	Dark yellow	490	Saws, bone and ivory	Dark purple	550
Dies, leather cutting	Straw yellow	460	Saws, circular for metal	Light purple	539
Dies, press, for brass	Light purple	530	Saw teeth, inserted	Straw yellow	460
Dies, press, for cold-rolled stock	Brown yellow	500	Saws, wood	Dark blue	570
Dies, press for leather	Straw yellow	460	Scrapers	Very light yellow	420
Dies, press, for paper	Dark blue	570	Scrapers for brass	Very pale yellow	430
Dies, screw-cutting	Straw yellow	460	Shear blades	Dark yellow	490
Dies, press, for sheet steel	Straw yellow	460	Shell reamers	Brown yellow	500
Dies, threading	Light yellow	440	Springs	Dark purple	550
Dies, wire-drawing	Straw yellow	460	Steel engravers' tools	Very pale yellow	430
Drifts	Brown yellow	500	Stone-cutting tools	Brown yellow	500
Drills, flat, for brass	Brown yellow	500	Taps	Straw yellow	460
Drills, flat, for iron and steel	Straw yellow	460	Tools, wood, not to be filed	Spotted red brown	510
Drills for brass	Straw yellow	460	Tools, wood, to be filed	Purple blue	530
Drills, rock	Straw yellow	460	Turning tools	Very pale yellow	430
Drills, twist	Brown yellow	500	Wood boring cutters	Brown yellow	500
Gages	Brown yellow	500	Wood engraving tools	Very pale yellow	430

Machinery

that by proper mixture, higher temperatures can be attained at a minimum of escaping gas or volatilization.

Cyanide Hardening Harmful to Steel

The following experience shows that the use of cyanide baths for hardening is often harmful to the steel, due to the extremely high carbon case, brittleness, and sharp line of demarcation. During the war there were two concerns engaged in the manufacture of a machine gun which used steel having the same specifications, or 0.45 to 0.55 per cent carbon. One concern, however, cyanide-hardened practically all the parts of the gun, which required a hard surface for wearing purposes. The other concern pack-hardened the gun parts in bone and charcoal, and finally hardened in a lead bath. The first concern was able to obtain a very high production in its hardening shop at a very low expense, because the large floor space necessitated for the regular pack-hardening process and the cleaning of the parts were not required. However, a number of the gun parts which were subjected to extreme shock conditions on the firing of the guns broke, and a thorough investigation of the trouble was made. A number of samples of cyanide-hardened work and pack- and lead-hardened work of parts picked at random were selected with samples furnished by the firm which used the pack- and lead-hardening process. This investigation was conducted at one of the government arsenals, a Charpy hardness testing machine being fitted up to strike the parts and thus affect them in the same way as the force of the explosion of the gun. It was interesting to note that about 20 per cent of the cyanide-treated parts broke readily, while the remaining cyanide-treated parts stood up and could not be broken, but none of the pack- and lead-hardened parts were broken. It might be thought that the steel from which the broken parts were made was faulty, but microscopic examination of the fractures failed to disclose such a condition or an extreme size of grain in the core. Everything seemed to point to the fact that the cyanide-hardened work was unstable and could not be depended upon under shock conditions. The photomicrographs, shown in Figs. 12 and 13 show the differences in effect on the steel of cyanide-hardening and pack-hardening. Fig. 12 shows a piece of 0.4 per cent carbon steel which was immersed in cyanide at a temperature of 1500 degrees F. for twenty minutes and quenched in oil. Fig. 13 shows a piece of the same steel after it had been pack-hardened in bone and charcoal, cooled in the pot, and rehardened in lead at a temperature of 1500 degrees F. Both samples were carefully annealed at the same time before polishing. The white surface seen in Fig. 12 is not decarburization, but is the zone of the high carbon content. Its resistance to the needle scratch can readily be seen. Note the lines of demarcation of case and core in both of the illustrations.

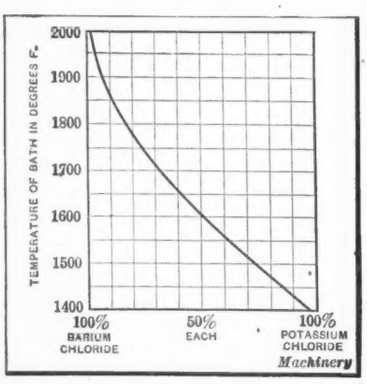


Fig. 14. Economical Percentages of Salts of Barium Chloride and Potassium Chloride to use for Various Temperatures

Sometimes cyanide is sprinkled on the work in powdered form as a quick means of obtaining surface hardness. The action is exactly the same as when the work is immersed, except that poorer results are obtained because the work is not exposed to the action of cyanide long enough to get the full benefit. Cyanide is often used for coloring work; if the work is removed from the cyanide pot and passed through a water spray into the water quenching bath, beautiful colors are given to the steel. The cleaner and smoother the surface of the metal, the better the colors will appear.

Use of Salt Baths in Hardening

Various salts may be used for hardening in place of cyanide salts. In this case no surface hardening is obtained, as the salts are heated and used as a bath in which to heat the work and to protect it against oxidation. Various salts are used, such as barium chloride, sodium chloride, potassium chloride, etc. The mixture of these salts to prevent too much waste from volatilization is an important consideration. The diagram Fig. 14, shows the percentages of the salts of barium chloride and potassium chloride which give the most economical condition of volatilization for the temperatures indicated.

Lead Baths

Lead baths are used more than salt baths for hardening, as there is less waste due to volatilization and sticking to the work, and owing to the weight of the bath there is less fluctuation in temperature when the temperature is high. Furthermore, work immersed in a lead bath heats quicker than when placed in a salt bath due to the better heat-conducting qualities of the lead, and oxidation is also prevented. Lead oxidizes on the surface as it melts and causes globules of lead to stick to the work, especially to threads on the work, etc., which causes inconvenience in cleaning. If the work is tempered after hardening, at temperatures exceeding the melting point of the lead, as in niter baths, the lead will in most cases be removed. The best method of preventing the lead from adhering to the work is to use a good grade of lead containing no tin; keep the molten lead surface covered with cyanide or other salts, or lumps of charcoal; skim the dross off the surface occasionally; and pour a little oil on the lead before adding new salts or charcoal. The cleaner and smoother the work is before immersion, the less the lead will stick.

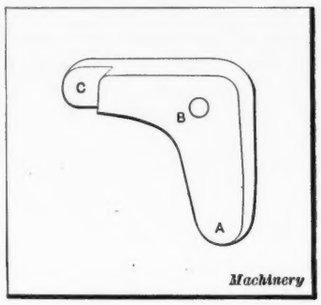


Fig. 15. Work having Different Degrees of Hardness at A, B, and C

The foregoing types of immersion baths are particularly adapted to work which does not require hardening all over, such as punches, drills, etc. They are further adapted to selective hardening, as on the piece shown in Fig. 15. This part was made from a piece of 0.25 per cent carbon steel and carburized. It was required to show a scleroscope hardness of 70 at *A*, 50 at *B*, and 85 to 90, or glass-hardness, at *C*.

The process, after carburizing, was to harden in an open furnace, draw in a niter bath to 700 degrees F., reharden end *A* in a lead or salt bath, draw the entire piece at 500 degrees F., and reharden end *C* in a cyanide bath.

* * *

There are two kinds of carborundum brick furnace linings: one, the recrystallized or refrax, and the other the clay-bonded, or carbofrax. In the first type, by heating the material in an electric furnace at a temperature of 2000 degrees C., a brick is formed which is well bonded and which has a tensile strength of from 1500 to 2000 pounds per square inch. Carbofrax bricks are made by bonding carborundum with a small percentage of clay and burning at high temperatures. The result is a hard stiff brick, very resistant to abrasion and capable of withstanding high heat. The fact that carborundum has such a low coefficient of expansion readily reduces breaking off and chipping when the brick is subjected to sudden temperature changes; consequently the life of the brick is greatly prolonged. Carborundum bricks retain their mechanical strength even at high temperatures and in this respect differ from most refractories. Carborundum is unaffected by acid or by burning oil. It will not stand the action of molten iron or steel, however, and is also decomposed by alkali at high temperatures.

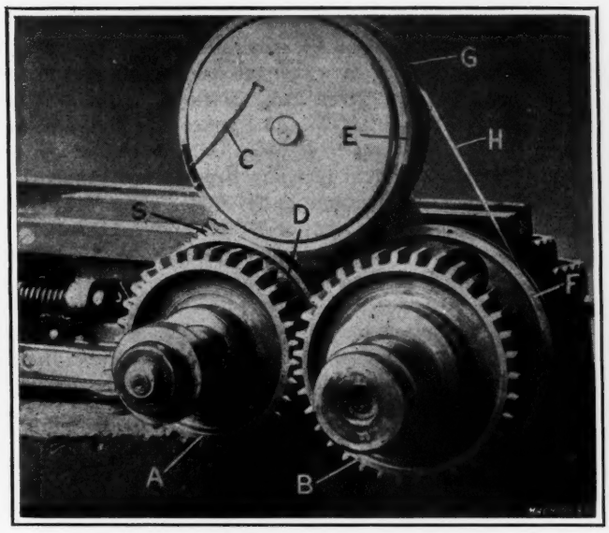


Fig. 1. Top View of Gear-testing Machine

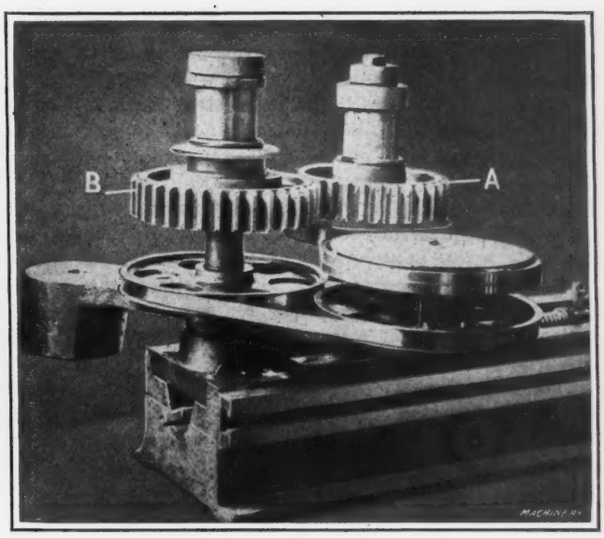


Fig. 2. Rear View of Gear-testing Machine

Gear-Testing Machine

A Machine Designed to Test Spur Gears for Accuracy of Tooth Profile and Concentricity

By G. WIRRER, Mechanical Engineer, International Motor Co., Plainfield, N. J.

BEFORE considering the construction and operation of the gear-testing machine shown in the accompanying illustrations it may be well to review briefly the principal reasons for developing a machine of this type. The quantity production of gears having the extreme accuracy required to insure long wearing qualities has been one of the most difficult problems encountered in the manufacture of engines and transmission gearing for automobiles. While modern gear-cutting machines are capable of maintaining a high degree of accuracy it is necessary that their tool equipment and adjustment be kept as nearly perfect as possible when employed for the quantity production of automobile gearing and gears used for similar classes of work.

Any slight error in the form of the cutter which produces the tooth profile, or any slight misadjustment of the gear-cutting machine will cause inaccuracies in the gear. In many cases it may be impossible to detect these inaccuracies by the usual inspection methods or with the instruments ordinarily available in machine shops. These minute defects may nevertheless be sufficient to cause premature breakage or undue wear, or they may cause slight but objectionable irregularities in the rolling motion imparted to a mating gear. From these brief considerations it is evident that the desired accuracy can be obtained and maintained only by providing means of testing the gears in such a way that these minute defects will not only be revealed, but their cause will also be readily determined.

The gear-testing machine shown in Figs. 1, 2, and 5 is the patented invention of the writer, and was designed primarily to record graphically any imperfections or inaccuracies in a pair of intermeshing gears (particularly in the involute of each tooth) as they come from the gear-cutting machine, so that any error or defect in the gear-cutter, or misadjustment of the gear-cutting machine could be detected and remedied. However, the machine has proved of great value not only in checking and recording the performance of cutters and gear-cutting machines, but also in recording the accuracy of the product after various subsequent opera-

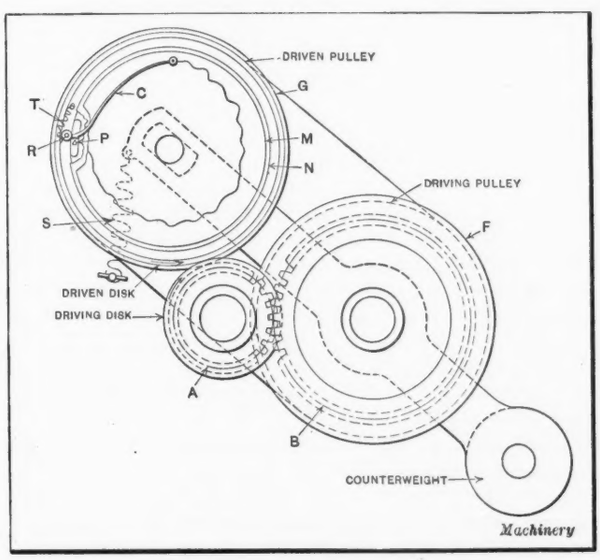


Fig. 3. Diagram illustrating Method of comparing the Rolling Action of Two Gears with the Rolling Action of Two Accurate Disks

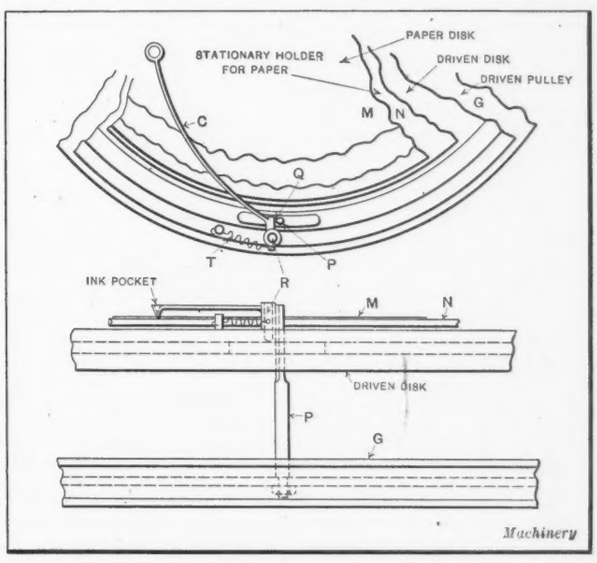


Fig. 4. Mechanism employed to record any Variation of the Rolling Action of Two Gears from that of Two Accurate Disks

tions, such as hardening and grinding. A machine with capacity for testing pairs of gears from 2 to 12 inches between centers is now being used in a large automobile plant.

The principle on which the gear-testing machine operates is the comparison of the rolling action of the pair of gears under test with the rolling action of two circular disks. The result of this comparison is graphically recorded by the testing machine on a chart, thus producing a permanent record. A careful inspection of the chart or diagram will generally reveal at once the nature of any defects detected and the cause of such defects. Briefly stated, the machine consists of a suitable mechanism for comparing the rolling action of the pair of intermeshing gears with the rolling action of two accurate disks.

The comparison is ordinarily made by mounting the pair of gears to be tested on the testing machine, which is shown in its normal position in Fig. 2. The machine may also be employed as shown in Fig. 5 for testing gears under load. Fig. 1 is a top or plan view of the machine. If only one gear is to be tested it must be mounted with a mating gear which has been previously tested and found accurate. When making the test, the shaft carrying pinion *A* is rotated by hand. This action may transmit motion in two different ways to arm *C*, which is provided with a suitable stylus for drawing the diagram: first, by means of disks *D* and *E* which are in rolling contact and have the same ratio as the gears being tested; and second, by means of pulley *G*, driven by belt *H* from pulley *F*. When the driven pulley revolves at exactly the same speed as the driven disk, carrying the recording arm, the pencil or stylus at the end of the arm will trace a concentric circle; but when the driven pulley either lags behind or rotates faster than the driven disk, the pencil arm is moved in or out and traces a spiral.

In either case the line traced will be practically smooth and continuous, that is, it will not have a jagged or broken appearance if the rolling action of the gears is perfect; but if the profile of any tooth is not correct in form, the line will be jagged (see Fig. 6). The nature of these irregularities enables any defect in the gear to be readily detected.

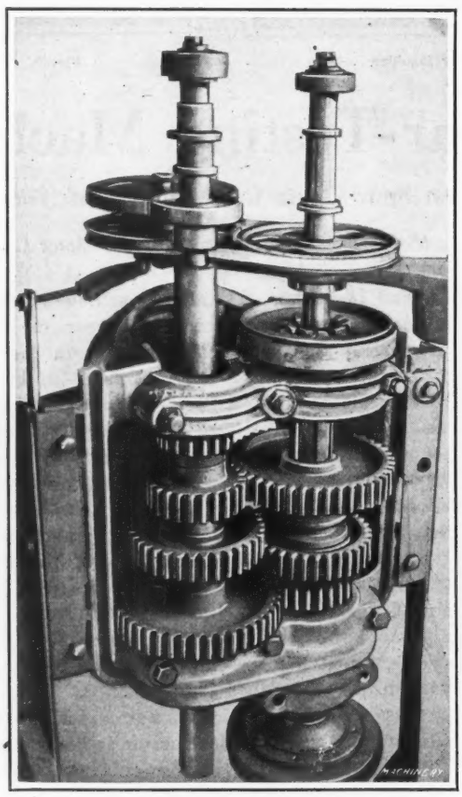


Fig. 5. Testing Gear under Load

The diagram Fig. 3, while not showing complete construction details, illustrates the general arrangement and function of the principal members which constitute the gear-testing machine. In this illustration, *A* and *B* represent the pinion and gear to be tested. As pinion *A* and the driving disk are secured to the same sleeve it is evident that the driven gear and driven disk will rotate or revolve at exactly the same speed. Then, as gear *B* and pulley *F* are secured to the same sleeve and the loose pulley *G* is mounted on a stationary bushing which is concentric with the driven disk, it is evident that both the driven disk and pulley *G* will be driven at the same speed when the shaft carrying pinion *A* is rotated, provided the rolling action of gears *A* and *B* is as perfect as that of the disks, which are held in rolling contact by spring *S*. To accomplish this, the diameters of pulleys *F* and *G* must be exactly the same. If there is the slightest irregularity in the rolling action of the meshing gears it is evident that pulley *G* will momentarily rotate faster or slower than the driven disk according to the nature of the defect in the gear or gears. The stylus arm *C* records these minute irregularities on the chart sheet *M*, placed on the stationary chart-holder *N*. The method of accomplishing this may be readily understood by referring to both Figs. 3 and 4. The fulcrum pin *R* on which the arm *C* pivots is firmly set in the rim of the driven disk, as shown in Fig. 4. Pin *P* is located in the pulley *G*, and contact is maintained between this pin and arm *C* at point *Q* by means of spring *T*. It is therefore evident that any irregularity between the motion of the driven disk and pulley *G* will cause the stylus to move either toward or away from the center of the disk in addition to the rotary motion produced by the revolving disk.

For purposes of comparison, it is possible to use not merely disks with diameters which correspond to the diameters of the gears to be tested but disks which correspond in ratio to the ratio of the gears tested, so that within certain limits gears of different pitch diameters but of the same ratio may be tested without requiring the disks which furnish the standard of comparison to be changed.

From the foregoing description it will be seen that if both gears are perfect, the path traced by the stylus upon the record sheet will be smooth and continuous, being circular if the speed of the driven disk is the same as that of the driven pulley, and spiral if the speed of these rotating bodies is not precisely the same. Any imperfection of any tooth, of either intermeshing gear, will obviously cause a temporary variation in speed of the two rotating bodies, one of which is driven in harmony with one of the intermeshing gears, while the speed of the other is dependent upon the action of the two intermeshing gears. Such temporary variation in speed of the two rotating bodies, one of which influences the stylus-supporting arm which is carried by the other, will produce a temporary departure of the stylus from the smooth continuous line, and the character and location of such temporary departure, as recorded by the stylus upon the record sheet, will indicate the character and the location of the defect in the gears.

Diagrams Indicating Typical Defects in Gears

In Fig. 6 is shown a diagram of an actual record which indicates imperfect rolling action and eccentricity. The size of the original diagram, however, is about twice that shown in the illustration. The actual outside diameter of a complete diagram is 6¾ inches. In Figs. 7 and 8 small sections of typical diagrams are shown to illustrate how the most common defects in gears are indicated by the diagrams and how the diagrams are employed to determine the cause of existing inaccuracies. At *A*, Fig. 7, is shown a section of a diagram produced when testing the accuracy of the gear-testing machine. In making this test, friction wheels were employed in place of the gears shown at *A* and *B*, Fig. 1 The smooth continuous lines resulting from this test indicate that the rolling action between the driving and driven disks of the machine and between the friction wheels employed to check the gear-testing machine is almost perfect.

The diagram shown at *B* was produced in testing a pair of gears as they came from the gear-cutting machine. This diagram shows that the gears were properly cut, the slight departure from a true curve being caused by tool marks. At *C* and *D* are shown the diagrams resulting from tests made on two pairs of gears which were cut with the same cutter but in two different machines. The purpose of these tests

was to check the accuracy of the gear-cutting machines. It will be noted that only slight departures from a smooth curve resulted from the first test. This indicates that the cutter employed was correct in form and that the gear-cutting machine was correctly adjusted. In the second test, the diagram *D* shows that the gear-cutting machine was either worn or improperly adjusted. This example illustrates quite clearly the method of employing the gear-testing machine to check the accuracy of gear-cutting machines.

The diagrams *E* and *F* were made in testing or checking the accuracy of two gear-cutters. In carrying out this test, the first cutter was employed to cut a pair of gears on a gear-cutting machine which had previously been tested and found accurate. These gears were then mounted on the gear-testing machine, and the diagram shown at *E* indicates the result of the test. The slight departure from a smooth circular line indicates that the cutter is very nearly perfect in form. After testing the accuracy of the first pair of gears, another cutter was mounted on the same gear-cutting machine and another pair of gears cut. In testing these gears, the diagram shown at *F* was produced. It will be noted that the line traced by the stylus in this diagram has a toothed appearance, which indicates that the contour of the cutter is defective. The two diagrams *G* and *H*, Fig. 8, resulted from tests made upon gears after they had been subjected to heat-treatment. In these cases the imperfect rolling action due to distortion in hardening is illustrated by the jagged appearance of the lines.

Diagrams *I* and *J* were made in testing a pair of hardened gears before and after lapping. Diagram *I*, while indicating that the rolling action was fairly good, shows the effect of tool marks by the large number of very slight irregularities in the lines. Diagram *J*, which shows the result of a test made after lapping the gears, indicates that the tool marks have been removed but that the true shape of the tooth has been destroyed. Diagram *K* illustrates the result of a test made upon a pair of very noisy gears, while diagram *L* indicates excessive eccentricity in a pair of noisy gears.

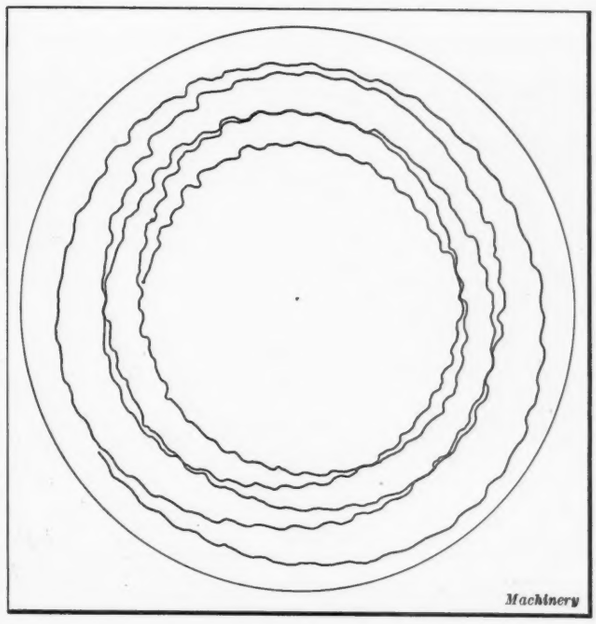


Fig. 6. Diagram indicating Imperfect Rolling Action and Eccentricity of Gears

* * *

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., recently transferred seventy-five of its engineers from the Pittsburg works to the South Philadelphia works in a very interesting manner. Contrary to the old system of having every man look out for a home for himself and his family, the company built a large number of houses at Lester, a suburban development within ten minutes' walk of the South Philadelphia works. Photographs were taken of the houses and sent to East Pittsburg, together with blueprints and plans. The engineers' families then selected from the drawings and photographs their choice of a home. Each man was given a blueprint plan of the house in which he was to live, showing the size and number of rooms. He then tagged all his furniture, numbered the tags, and indicated by the same numbers on the blueprints where each piece of furniture should be placed. The packing, crating and shipping of the furniture was then taken care of entirely by the Westinghouse company, which engaged transfer and storage companies in Pittsburg to take charge of this work. The entire household effects of the seventy-five families were then taken to Philadelphia and unpacked by the transfer companies in the new house, so that when the families arrived in Philadelphia, they found their homes ready to move into, with all the furniture in place.

* * *

In mending belting wherever belts are exposed to steam, it is not advisable to use glue. The steam will dissolve it and the joint will soon break. The only adhesive that will hold under these conditions is a pyroxylin cement which, being waterproof, will withstand the steam and moisture.

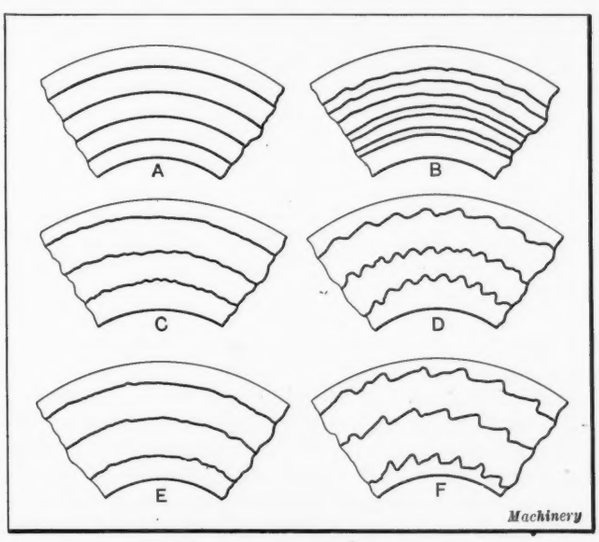


Fig. 7. (A) Section of Diagram indicating Perfect Rolling Action. (B) Properly Cut Gears. (C) and (D) Diagrams from Two Pairs of Gears cut with the Same Cutter but on Different Machines. (E) and (F) Diagrams from Two Pairs of Gears that were cut in the Same Machine but by the Use of Different Cutters

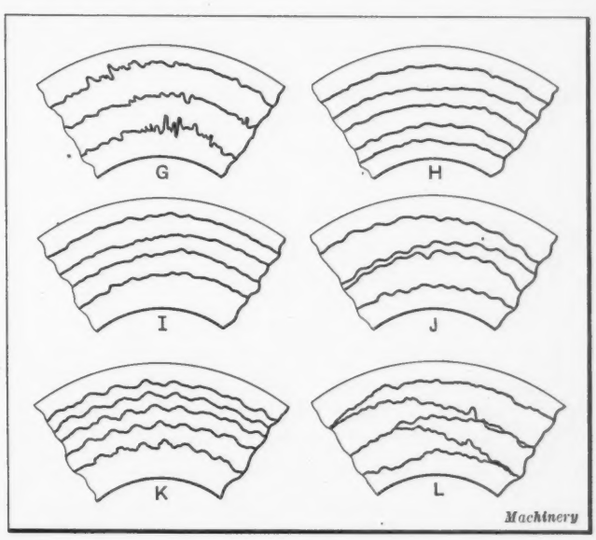
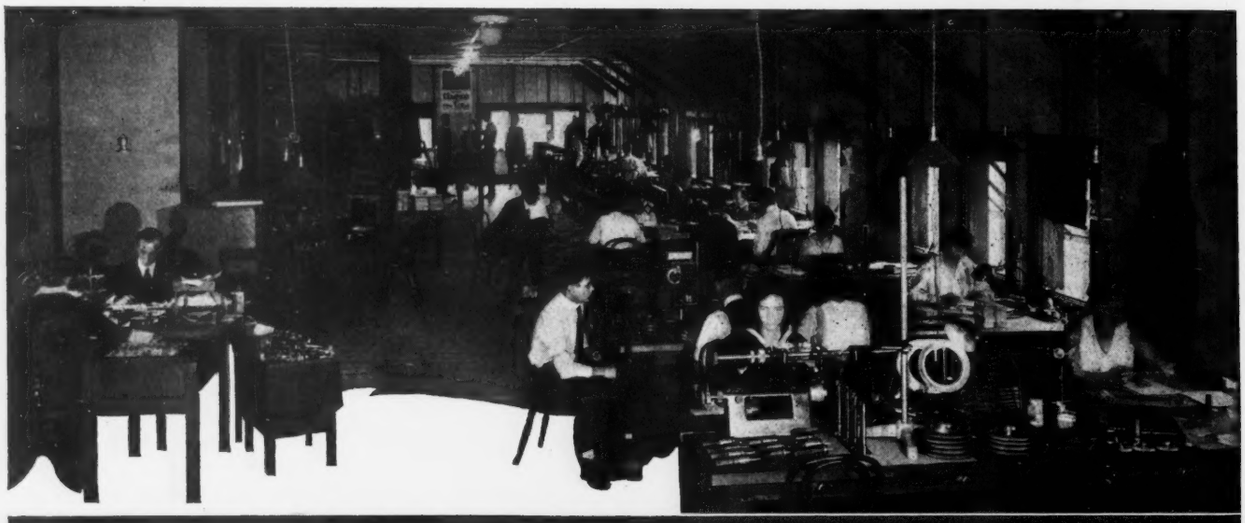


Fig. 8. (G) and (H) Wavy Lines indicate Imperfect Rolling Action due to Distortion in hardening. (I) and (J) Diagrams made before and after lapping Hardened Gears, indicating that Shape of Tooth has been destroyed by lapping. (K) Example of Noisy Gears. (L) Noisy and Excessively Eccentric Gears



Economical Interchangeable Manufacturing Practice

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

Specifications and their Use in Interchangeable Manufacture—Use of General and Specific Production Data—Factors Entering into Production Costs

THERE are three principal elements in the economical and successful production of a commodity. Stated briefly, they are as follows: (1) A thorough knowledge of the object (function) of the article and of all the conditions essential in attaining it. (2) The development of manufacturing methods and facilities that will most economically produce a satisfactory product. (3) The development of testing methods and apparatus to determine in an economical manner, at any stage, whether or not the desired results are being achieved.

Duplication of work never results in economy. Therefore, a record should be made of any solution reached in regard to these questions. Almost every problem has more than one satisfactory method of solution. The multiplication of solutions, however, particularly in manufacturing, is a hindrance to teamwork. For example, if the foreman of one department uses one solution of a problem, while the foreman of another department who performs succeeding operations on the same or companion parts arrives independently at another solution and uses it, the final results may be chaos; whereas, if each solution is recorded, whenever or wherever made, an opportunity is created to check these solutions against each other, thus making possible the elimination of inconsistencies at an early stage of the work. This practice will aid greatly in promoting teamwork, and thereby eliminate many misunderstandings.

Whenever any important decision is made, it should be recorded in the specifications together with the reasons therefor. This practice tends to eliminate many expensive, unnecessary refinements which are often specified arbitrarily. Instead of baldly specifying the various requirements, this practice requires the addition of sufficient reason for such requirements. This in turn, demands a careful analysis of the mechanism and its purpose; and a careful analysis of almost any mechanism will soon make it apparent that only a small proportion of the detailed dimensions and other requirements are exacting. Attention is called, in this respect, to the preceding articles, "Practice in Making Component Drawings," published in the January and February numbers of MACHINERY.

Specifications, in their broadest sense, include the solutions of all the three problems mentioned. This information may be compiled and recorded in one place or it may be scattered throughout the plant. In general, if the entire control of the design and manufacture of a commodity is held in one plant, the compiling and assembling of much of this information may be of doubtful value. As long as it is on record somewhere and available when needed, that is sufficient. On the other hand, if the control of the the design rests with one organization, the control of the production with another, while the control of the final inspection is distinct from either of the two foregoing establishments, reasonably complete specifications are imperative if economical and expeditious production is to be obtained.

Specifications, thus defined, include component drawings. For purposes of discussion, however, we will consider component drawings and specifications as distinct. In this case the specifications are supplementary to the component drawings and include all information which is not given on these drawings.

When certain manufacturing methods are to be decided upon, the decision made in this connection should be recorded, together with the reasons for it. This practice tends to eliminate many expensive, unnecessary refinements which are often arbitrarily specified, because, instead of baldly specifying the various requirements, the necessity for adding sufficient reasons therefor demands a careful analysis of the mechanism and its purpose; and a careful analysis of almost any mechanism will soon make it apparent that only a small proportion of the dimensions and other requirements are exacting. This and many other subjects bearing upon the attainment of economical practice in interchangeable manufacturing are dealt with by Mr. Buckingham in the present article.

Function and Essential Requirements of Product

The component drawings consist of pictures of the parts, statements of the physical dimensions required, and usually, specifications of the material to be employed. By themselves, they only partially solve the first of the major problems noted previously. They tell little or nothing of the object of the commodity. They state requirements, but give no reasons therefor. Thus, the first function of the specifications is to state briefly the purpose of the mechanism and its functional requirements. The articles "Practice in Making Component Drawings," published in the January and February numbers indicate the lines which specifications should follow.

A second function of the specifications is to indicate the quality of workmanship desired. The extent of the tolerances given on the drawings indicates, to a certain degree, the proper character of the finished surfaces. The specifications should supplement this information by stating not only desired results, but also reasons therefor. The preceding articles previously referred to, illustrate this practice. To a certain extent, perhaps, many of the conditions discussed there are so obvious as to need no mention, yet no harm is done by being explicit.

Another subject to be included in the specifications is the matter of the materials to be employed, and their nature, composition, and ultimate use. When standardized material is used, this can be called for directly on the component drawing, together with the proper heat-treatment. It is of interest to note that the Society of Automotive Engineers has done much valuable work in establishing standard specifications and methods of heat-treatment for nearly every kind of material used in automobile construction. The adoption of such standards greatly simplifies the provision of proper component drawings and specifications. In those cases where standardized material cannot be used, the specifications should give all pertinent information to enable the proper material to be secured. Whenever preservative finishes are required, the drawings or specifications should give complete information as to their nature, need, and use.

The first function of specifications is to state briefly the purpose of the mechanism and its functional requirements. The second function is to indicate the quality of workmanship desired. The tolerances given on the drawings indicate to a certain degree the character of the finished surfaces. The specifications should supplement this information by stating not only the desired results, but also the reasons therefor. The third function of the specifications is to give the materials to be employed, their nature, composition, and treatment. The adoption of standard specifications for materials and standard methods of heat-treatment greatly simplifies the method of specifying materials and treatment on drawings and in specifications. Whenever preservative finishes are required, the drawings or specifications should give complete information as to their use. If these simple rules are followed, much time and expense are saved in the manufacturing processes.

When the component drawings have been completed and the specifications have reached this stage, the first chief elements of the work are established. Until this is accomplished, those responsible for the manufacturing design have not done all in their power to secure the economical production of duplicate mechanisms in large quantities. Undoubtedly, many minor revisions will be required before the proper solutions of the succeeding problems will be found. But without the foregoing information, such revisions cannot be made intelligently. Furthermore, this information, in most cases, will point the way to a simple and direct solution of the succeeding problems. "Well begun is half done" was never nearer the truth than in connection with interchangeable manufacturing.

Specific Manufacturing Data

We will now consider the solution of the second major problem—the development of suitable manufacturing methods and facilities. The first step to be taken is to make up the operation lists for every component, noting in detail the type of machine, fixture, and tool required. It is of great assistance in many cases to develop concurrently the operation drawings, indicating on them the work to be performed at each operation. In addition, it is a good plan to include in this part of the work an estimate of the production time on each operation. This information is necessary to establish the amount of equipment required and also to make a comparison, when desired, of the economy of several methods.

This information should be revised and kept up-to-date after production is under way. This furnishes valuable data for estimating on new commodities and facilities comparison between the costs of different methods of manufacturing. Such information is invaluable when it becomes necessary to call on outside plants to assist in obtaining greater production. It need not be bound together with other parts of the specifications, but it should be in such shape that it can be quickly found and readily applied. The foregoing information serves as the basis for designing the special manufacturing equipment necessary as well as for arranging the manufacturing departments so that the component parts can be produced rapidly and efficiently.

This second problem is seldom or never fully solved. Improved methods are being devised constantly, and these introduce new factors into old problems. Even greater care must be exercised in adopting a new method on work already in process of production than is required in adopting the original methods, because in these cases, ultimate economy requires that such changes result in a saving which will pay for the discarded equipment as well as for the new. The effect of a possible interruption in production must also be carefully considered.

The production records of the manufacturing equipment should be so kept that it will be always possible to trace back through every change in equipment and make direct comparisons between the results obtained by each method. At the same time, these records should be so simple as not to entail unnecessary clerical expense. Whenever a change is made, the reason for making it should be on record. All these data furnish information which cannot be secured in any other way. As a matter of fact, many plants keep a complete record of changes, but do not provide this class of information when the production of an entirely new mechanism is undertaken.

General Manufacturing Data

In addition to the specific information required for each individual part and each assembled mechanism, there is a vast amount of general data which must be had before decisions as to the economy of different methods of manufacture can be made with certainty. Much of this information should be available from the cost department records, but, in most cases, these records are kept merely for accounting purposes and their use as engineering data often gives incorrect results.

Factory Cost of Production

It is not the purpose to outline here a new system of cost-accounting. A discussion of some of the factors entering into the factory costs of production, however, is necessary to indicate the character of the information needed to promote economical production. For the purpose of simpler accounting, it is often customary to prorate the entire amount of indirect or overhead charges against the total output of the plant, distributing them according to the direct labor costs.

From the accountants' viewpoint, this method is correct. If the product of the plant consists of one simple specialized article, such a method of accounting undoubtedly gives sufficient data for general engineering purposes. On the other hand, if the products are varied, or if the productive operations are sub-divided into elementary operations, performed in various departments, the data so collected are incomplete and misleading for engineering purposes, because the direct labor cost alone will be the determining factor in selecting the apparent economical methods of production. As a matter of fact, this direct labor cost is but a small percentage of the total cost of production. It seldom amounts to 25 per cent. Furthermore, as the volume of business increases, the percentage of direct labor charges decreases. Thus, as the quantity of production increases, the data so obtained become more and more unreliable.

Another method of distributing the indirect expense consists in establishing overhead rates for each department, prorating these charges in proportion to the direct labor cost as before. If the departments are arranged to contain only one type of equipment, and to perform similar operations, the data so obtained are valuable, but such an arrangement of machines and operations is seldom possible or desirable. Different types of work creep into a department. When this condition exists, the information obtained from the use of a departmental overhead will again lead to false conclusions, causing the acceptance of manufacturing methods that are not economical.

Certain types of equipment are always duplicated to some extent in several departments. All other things being equal, the cost of duplicate operations on duplicate equipment is identical regardless of the physical location in the plant. But with the use of departmental overhead charges, the book costs will show otherwise. For example, in one plant a sheet-metal part required a foot-press operation between two power-press operations. Foot presses were available in two departments: the power-press department with an overhead charge of 150 per cent, and a sub-assembly department in a distant part of the factory with an overhead charge of only 50 per cent. The original operation list assigned all three operations to the power-press department to eliminate unnecessary trucking and transfer. This was changed so that the second operation would be performed in the other department because of the lower overhead there. Actually, this last method cost more than the first because of the trucking and transfers back and forth, but because the book records showed a higher cost for the first method, it was disapproved despite all arguments. This is not an extreme case. Similar conditions exist in the majority of manufacturing plants.

It is realized that book costs and actual costs are not identical. To obtain such accuracy would entail a system so complex and elaborate that its cost alone would overbalance all other expenses. Yet some simple way must be found to give more nearly true costs of production in order to promote true economy of manufacture. The direct labor and direct material costs are readily obtained. Most accounting methods apply these charges directly against the individual parts, which is the proper distribution. But this, in most cases, disposes of less than half of the total cost of production. Indirect expenses are not only the most difficult to distribute equally, but also involve the larger amount of the costs. The total amount of these charges can be easily determined. This is purely a matter of bookkeeping. Their equitable distribution, however, is more an engineering than an accounting problem.

It is not an easy matter to properly distribute the indirect expenses that should be added to the direct labor cost. One charge against labor is the cost of supervision, as represented by the salaries of foremen and their assistants. This charge is often divided equally among the number of men employed, but this method is somewhat erroneous, because higher-priced men require proportionately less supervision. It would be more correct and logical to proportion this charge in an inverse ratio to the wages of the men, but the clerical work necessary to do this would cost more than the information would be worth. The cost of time-keeping and the making up of the payroll should logically be distributed equally between the men employed, as it costs practically as much to keep the time and make up the payroll for a man earning $15 a week as it does for one earning $30. Matters of this kind are, however, of great importance in determining actual costs of manufacture.

Distribution of Indirect Factory Expenses

There are three main factors to which most of these indirect expenses can be logically applied: First, the direct labor; second, the general productive equipment; third, the component parts themselves. There are also a number of other indirect expenses which must be charged to the general factory expense. As these are relatively few, they can be arbitrarily distributed over the entire product without affecting the value of the data sought. Eventually, of course, the product must carry them all. The great problem is to distribute them simply and properly.

If the attempt is made to apply all indirect charges to any one of the above factors, many economic errors will result. Attempts have been made to carry them all on the direct labor factor with far from satisfactory results. Neither can they all be applied to the equipment factor with any better results. Each factor must bear only its own indirect expenses. In order to determine where each indirect expense belongs, a process of elimination should be adopted. Without such a factor, would this expense exist? If the expense remains after direct labor, general productive equipment, and individual components are eliminated, it belongs to the general factory expenses or factory management.

Direct Labor

Let us first consider the indirect expenses due to direct labor. Hereafter, for the sake of brevity, direct labor will be referred to as labor. One charge against labor is the cost of supervision as represented by the salary of the foremen and their assistants. The number of these depends chiefly on the number of men to be controlled. This charge could be prorated against the number of men employed. Such a method might, in extreme cases, be erroneous because the higher-priced men should require less supervision. Although, in such cases, it might be more logical to proportion this charge in an inverse ratio to the wages of the men, the clerical work necessary to accomplish this would cost more than the information would be worth.

The cost of time-keeping and making up the payroll logically belongs to the labor factor. Eliminate labor and you have no payroll to make up. This should also be distributed on the basis of the number of men employed, as it costs as much to make up the pay account of a man getting fifteen dollars a week as it does to make up the pay account of a man getting thirty dollars. Here again, the indirect expense of high-priced labor is proportionately less than that of lower-priced labor.

The cost of the employment department also belongs to the labor factor. Eliminate labor and you have no further need of an employment bureau. These charges should also be distributed on the basis of the number of men employed, for it costs as much to hire one man as another. In many cases the higher-priced men are the most reliable—not always, of course, as so many other conditions enter into this—and thus it is possible that a closer result would be obtained by distributing the cost in an inverse proportion to the wages of the men.

Wherever personnel or educational departments are established or other similar departments whose objects are to promote cooperation between the employer and employe to their mutual advantage, all expense incurred should be charged against labor. It is extremely difficult to analyze such charges accurately—so much depends upon the nature of the activities of such departments and upon the character of the persons with whom they deal. Therefore it might be best to distribute these charges also on the basis of the number of men employed so as to simplify the accounting by prorating all labor charges in a uniform manner.

The items that make up the machine-hour rate are interest on investment, depreciation, and insurance. Next in order come maintenance charges, which, as well as the first items mentioned, can be distributed to particular types of machines. There are many minor items, however, which have to be distributed over the entire equipment. The cost of the space occupied by the entire factory should be distributed over all the machines, proportionately to the average amount of floor space that is required for setting and operating each type of machine. Power charges also must be included in establishing the machine-hour rate.

All charges for installing safety devices, fire escapes, improved sanitary equipment, for heating and lighting, and other similar expenses necessary for maintaining the health and safety of the employes as required by law or promoted by the dictates of humanity, belong to the labor factor. However, some of these expenses might be included in other general items—fire escapes may be included in the cost of the buildings, for example—and it may not be possible or feasible to isolate them. Those few cases where it is not practicable to apply expenses directly where they logically belong will not affect appreciably the values of the final data.

It should offer no great accounting difficulties to isolate the majority of the expenses enumerated and all other kindred items. This is all that the accountant would necessarily do. The total amount so determined could be prorated on the basis of the average number of men engaged in actual production, and thus give the labor overhead. This would be used as a constant for a predetermined period in a similar manner to the usual overhead charges, and would be close enough for all practical purposes. Of course, it is evident that this labor overhead fluctuates constantly, but as these data are for the use of engineers and not accountants, an exact balance is not essential. As a matter of fact, the use of a general overhead burden does not give an exact balance. A comparison between estimated results and the accountants' records will show how wise a use has been made of this information. This direct labor overhead is a valuable factor in determining economical methods of production. If the general type of labor employed differed to any great extent in the various departments, a separate labor overhead could be established for each department.

Machine-hour Rate

We will next consider the indirect charges that belong to the general productive equipment which, prorated on an hourly basis, we will call the machine-hour rate. The first items are the interest on the investment, depreciation, and insurance. These are relatively simple to determine. Their maintenance charges belong here also. When possible, these should be applied to the particular types of machines. The many petty items would be distributed over the entire equipment. Having the machinery, we must have a place to put it. The majority of the factory space is utilized by productive equipment. It would seem, therefore, that all our fixed plant charges would be best distributed here. This could be done proportionately to the average floor space required for operating each type of machine.

There is a certain amount of idle time for any machine, no matter how well the work is planned. The amount of this non-productive time varies for different types of machines. For example, an automatic screw machine—as efficient a productive machine as could be used for an illustration—is idle on an average of one hour in five. This idle time is caused by the necessity of adjusting tools, oiling, changing bars, etc. Therefore, the actual productive time of this machine is eighty per cent of its total operating time. The percentage of non-productive time should be estimated as closely as possible and included in the machine-hour rate; otherwise the cost of manufacture, based on the machine-hour rate, will be erroneously estimated.

The power charges would also be included in the machine-hour rate. One cannot go into the exact distribution of this factor without incurring great expense in power tests—tests that become valueless as the machining cuts vary from light to heavy, short to long. An approximation could be made which would determine the value of this factor close enough for practical purposes. A few power tests could be made to advantage for the purpose of securing data to assist in the proper distribution of all power costs. The cost of belting and lubricating oils, etc., could also be included in the total power charges. Such a plan would insure an equitable and simple method of distributing these.

There is always a certain amount of idle time for any machine, no matter how well the work is planned. The amount of this normal non-productive time varies for different types of machines. For example, an automatic screw machine—as efficient a productive machine as we have—is idle on an average of one hour in five. This idle time is caused by the necessity of adjusting tools, oiling, changing bars, etc. Therefore, the actual productive time of this machine is 80 per cent of its total operating time. In the printing trades, where a complete system of machine-hour costs has been developed, 65 per cent is considered as a normal average of productive time. The normal percentage of non-productive time should be estimated as closely as possible and included in the machine-hour rate.

There is, however, another source of idle time to be considered. This may be lack of work or lack of labor. If it is lack of labor, it should logically be charged against the employment department. Lack of work may, of course, be due to one of several causes. If due to lack of business, it could be charged against the sales department, while if due to poor planning, it belongs to the general factory expense. For simpler accounting, abnormal idle time might best be included in the general factory expense.

The shop office carries records of the machinery, such as inventory lists giving the original value, depreciation, locations, etc. The results of using machine-hour rates would be, to all intents and purposes, the creation of a payroll for the various machines. All this would require a certain amount of clerical work, the cost of which should be prorated against the machines.

The accountant would carry accounts showing only the total amounts spent for power, belts, lubricating oil, fixed plant charges, fixed charges on general manufacturing equipment, labor costs for machine records, etc. These totals would be prorated as discussed above to establish a constant machine-hour rate for each type of equipment, which would be simple to apply. Such values would be adjusted periodically as required. Here, again, the successive reports of the accountant would make apparent how wise a use had been made of the information so gathered.

We, in the mechanical manufacturing industries, would find it well worth our while to follow, in one respect at least, the

example of the printing trades. The problem of the actual cost of production has been studied by them on a cooperative basis. For several years, one of their trade journals has been collecting cost data from many plants throughout the country. The information so willingly given has been compiled and analyzed for the benefit of all. As a result, a complete series of average machine-hour costs has been developed, the use of which gives results very close to the actual balances of the accountants. This data is kept up-to-date and corrected values are distributed periodically. This information is invaluable for estimating and other planning purposes.

Improved methods are constantly being devised and new factors are thereby introduced into old problems. While great care must be exercised in adopting any method for performing work for interchangeable manufacture, still greater care must be exercised in adopting a new method on work already in process of production, because in these cases ultimate economy requires that the changes should result in a saving which will pay for the discarded equipment as well as for the new. The effect of a possible interruption in production while the change takes place should also be carefully considered before a new method is instituted.

Product Overhead

We will now consider the indirect expenses due to the product itself. The following method of distributing indirect costs is a radical departure from any established practice, yet their logical distribution leaves no other path open. There are two classes of these charges; those which can be applied to specific component parts and those which apply to the whole product in general. For the sake of brevity, we will call those of the first type, specific product charges and those of the second, general product charges.

The most important specific product charge and the one most readily isolated is that for jigs, fixtures, special tools, and gages. These certainly belong to specific parts. The adoption of this practice will soon develop a valuable record. It will then be possible to obtain—and apply directly where it belongs—the cost of making changes in the design and methods of manufacturing of the various parts. Then only will it be possible to determine whether or not such changes result in an economic gain. The writer believes that frequent changes of this sort are altogether too common in American manufacturing practice. Judging from personal experience during the past ten years, the majority of such changes are the results of mental laziness. When the first important difficulty appears, we avoid the issue instead of carrying it through to its logical conclusion. It is the easiest thing in the world to try to make a part in a different way from the one originally planned; but by so doing, we merely substitute one set of difficulties with which we are somewhat familiar for others with which we have had no previous experience, and, in the end, we find ourselves at the same place from which we started. The writer feels safe in stating that not less than seventy-five per cent of the changes made are attempts to avoid trouble which is not eventually escaped, and that this percentage of the cost of changes represents a total economic loss. A method of distributing indirect expenses along the lines indicated above will expose such conditions as nothing else will.

Another specific product charge is the cost of constructing special machines for specific parts. This is logically included in the jig and fixture costs. When the special machine is used on several parts, these expenses, of course, will be classified with other general machinery items. Its normal non-productive time, however, is usually large.

The loss resulting from scrapped work is another specific product charge. Some parts are delicate and difficult to machine and this results in a high percentage of scrap. Others are simple and more rapidly produced with little or no scrap. It is manifestly unfair to distribute this item of expense over the product as a whole because this will give an entirely wrong idea in regard to the economy of the simpler and sturdier designs. Often, when the design is changed, a large number of finished parts are scrapped or reworked. All such expenses should be charged to specific pieces when possible. There will, of course, be some credit items, due to salvage. If it should be difficult and expensive to distribute these salvage credits specifically, they could be credited to a general scrap account and applied proportionately to the cost of the scrap charged against each part. Any inaccuracy resulting from this procedure would have little effect on the value of the final result.

Most of the other expenses incurred by the product are general product charges. Among them would be the cost of trucking, including the interest on the investment of the trucks, elevators, etc., depreciation, and their maintenance costs. The expenses of shop rearrangements also belong with the general product charges, as these alterations are made to facilitate production. If, however, they can be charged directly to specific component parts, they should be so distributed. The majority of the factory office expenses would be included in the general product charges. This would include the cost-keeping, production records, engineering and experimental work, etc. All these general product charges could be distributed in conjunction with the general factory expenses. This method would be as equitable as any.

Let us now consider the clerical and accounting work which such a procedure would entail. First, the accountant must arrange his books so as to separate all expenses due to direct labor. This would only be a single account. Next he would open another account to carry all the expenses making up the machine-hour rate of the general productive equipment. Another account would be opened for the indirect charges due to the product. The indirect charges caused by the purchase and handling of the material have not been previously mentioned. These would be handled in the same manner as the other indirect expenses, and distributed over the direct material. The accountant would carry this account, and one to cover the general factory expenses which are not distributed elsewhere. These would be all of the indirect factory expense accounts which he would require. He would also carry direct labor and material accounts. The sum of these accounts would represent the factory cost of production of the work produced during a given period. This, balanced against the value of the output would represent the gain or loss during the specified period. This is the essential information in which the stockholders and directors of a plant are interested.

The production records relating to manufacturing equipment should be so kept that it may always be possible to trace back the effect of every change in equipment and make direct comparison between the results obtained by the use of different methods. At the same time, these records should be kept in so simple a form as not to require unnecessary clerical expense. Emphasis should be placed on the point that whenever changes are made, the reason for making the change should be recorded; otherwise, there may arise conditions in the future when a change back to the original methods may be decided upon without any actual knowledge of the reasons why they were abandoned.

The factory cost department would carry independent accounts along entirely different lines. These should give detailed information in regard to the cost of each component. They need not necessarily check exactly with the accountants' records. The constants which are used by the factory should be so estab-

lished as to make the total of these records a small percentage higher than the accountants'. A factor of safety of, say, 5 per cent, should be included in the various constants. The direct labor and material charges are the only ones which should check absolutely in both sets of records, while all the others need check only within the limits of the factor of safety established. The various constants would, necessarily, be adjusted from time to time to bring this result.

The factory cost department would carry an account for each separate component, including sub-assemblies and complete mechanisms. Records must be kept on each of these accounts, showing the direct labor, direct material, machine-hours, special equipment, and scrap charges. To this would be added the proper direct labor overhead, direct material overhead, machine-hour rates, general product overheads and general factory expense. These last would be specified constants. The comparison of these shop records with the accountants' records would prove, first, the relative accuracy of the established constants, and, second, how effective a use had been made of the data that was so collected.

If it were possible for several manufacturing concerns to adopt a method of factory cost-keeping along the lines outlined in this article and to compare, from time to time, not the details, but certain of the resultant factors, much valuable information would be secured—information which would not in the least reveal any of the confidential data of the business, but would uncover many economic truths as yet undiscovered. For example, it is of the utmost value to determine what the normal direct labor burden should be. The different plants involved in such an undertaking need not be engaged in the production of the same commodities, and their methods of manufacture might differ in many particulars, yet from data so obtained the normal cost of this factor could be determined very closely. These plants would thus establish a standard with which to compare their costs. The same is true in regard to the machine-hour rates. With cooperation between a large number of plants, an accurate series of values could be established for these rates.

If it were possible for several manufacturing concerns to adopt a method of factory cost-keeping along these lines and to compare, from time to time, not the details but certain of the resultant factors, much valuable information would be secured—information which would not in the least reveal any of the confidential facts of the business but would uncover many economic truths as yet undiscovered. For example, it is of the utmost value to determine what the normal direct labor burden should be. The different plants involved in such an undertaking need not be engaged in the production of the same commodities, and their methods of manufacturing might differ in many particulars, yet from data so obtained the normal cost of this factor could be determined very closely. These plants would thus establish a standard with which to compare their costs, giving them either the gratifying knowledge that their labor burden was normal or else a warning of conditions that should be corrected. The same is true in regard to the machine-hour rates. With cooperation between a large number of plants, an accurate series of values could be established for these rates. Accuracy or precision in manufacturing requires established standards. Why should not the same principle be applied to our other problems? If we establish relative standards for machine-hour rates and direct labor overhead, for example, we are justified in looking forward to the same progress in these respects as we have made in our mechanical work since the establishment of physical standards. It may be a long and slow process, but we shall be conscious and certain of improvement during its development. The product factors would be of little value for general comparisons. Their nature prevents their economic use for this purpose.

Inspection and Testing

The third major problem—the development of inspection methods and facilities—should be solved to a great extent in conjunction with the development of the other manufacturing equipment. The inspection operations and necessary gages should appear in their proper place on the operation lists. In some cases, these lists should be supplemented by a more detailed description of the methods of inspection. This is unnecessary for limit gages measuring elementary surfaces. It is required, however, in connection with the use of functional and other gages for many composite surfaces. Such information should be included in the specifications as an integral part of the description and requirements of each component part.

Specific and General Information

It is obvious, then, that specifications may be divided into two main divisions. The first division contains the specific information required in the production of particular commodities. The preceding articles "Practice in Making Component Drawings," published in the January and February numbers give a good illustration, as far as the requirements of dimensions and surfaces are concerned, of the nature of specifications of this class. Operation lists, material specifications, inspection requirements, etc., are needed to make them complete. In this way, the efforts of all will be directed along similar lines, the exacting requirements will receive the greatest attention—and this they should always receive—while those of lesser importance will be treated accordingly.

The second division consists of that vast amount of general information that is derived from our cost and production records, "traditions of the shop," and all other general data gleaned from every possible source which applies equally to every commodity. This should not be duplicated in the written specifications of every individual commodity, but should be gathered independently in usable form.

The next article on this subject, which will be published in the April number of MACHINERY, will discuss equipment for interchangeable manufacturing, laying down the principles involved in the selection of machine tools and in the proper designing of jigs, fixtures, and cutting tools.

* * *

BRITISH WROUGHT IRON INDUSTRY

The wrought iron industry in England has been considerably hampered during the last few years due to lack of men, particularly puddlers. Staffordshire is the principal seat of the wrought iron industry, there being from 600 to 700 puddling furnaces in that district, all operated by hand. These furnaces have a total capacity of over half a million tons of puddled bars per year, and in the past used to employ 10,000 men; but even before the war, there was the difficulty of obtaining the required number of men. When the war began, this shortage was accentuated by the rush of the men to the colors and by the unfortunate delay in stopping the outflow of experienced puddlers who could not be replaced. Experiments in mechanical puddling have never been viewed with much favor in England and the results achieved have been unable to overcome the prejudice against it. It has become necessary, however, during the past year, to experiment with a new system of mechanical puddling in order to overcome the condition existing due to lack of experienced puddlers. As England has furnished the world with its principal supply of high-grade wrought iron, any curtailment of this industry would be serious, both from the British point of view and from that of other nations who have obtained the wrought iron now used mainly from British or Swedish sources.

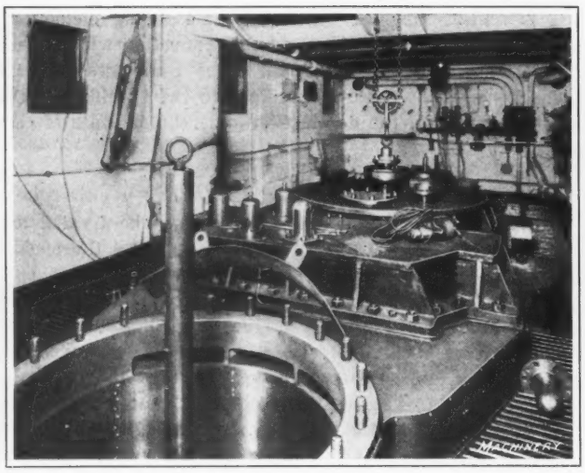


Fig. 1. General View of Engine Room and Cylinder undergoing Repair

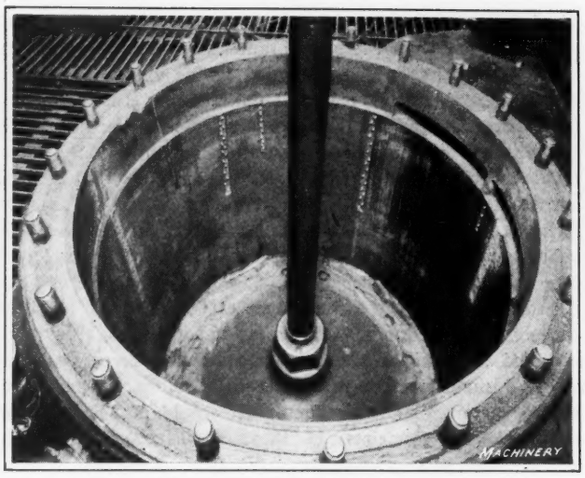


Fig. 2. Interior of Cylinder showing Two Welds Ready for Grinding

Welding the Interior Surface of a Cast-Iron Cylinder

By OTIS ALLEN KENYON

ALTHOUGH skilled workmen have been welding cast iron by means of the arc-welding process for many years, there are no fixed rules which can be followed in the employment of this process for repair work. Each job is a problem in itself, and in many cases considerable study and ingenuity on the workman's part is required to make a satisfactory weld. Arc-welding outfits have been greatly improved in recent years, but up to the present time much more depends on the welder's skill than on the welding outfit, provided the system will supply the necessary current and voltage. As the conditions which must obtain in order to produce a satisfactory weld are not generally understood, the writer has taken this opportunity to preface the present article with a brief analysis of the difficulties encountered in making cast-iron welds.

For the purpose of analysis, it is possible to separate the difficulties encountered in welding cast iron into three general classes:

1. The production of extremely hard and brittle metal at the fusion line between the casting and the deposited metal.
2. Failure due to shrinkage strains in the weld.
3. Failure or distortion due to temperature stresses in the casting.

The layer of glass-hard metal at the fusion line is due to the absorption of carbon from the cast iron by the freshly deposited metal; after this occurs, the sudden chilling action of the massive casting produces the hardest kind of high-carbon steel. The only way to avoid the effect of this carbon absorption is to remove the carbon from the weld. Up to the present time the success of every process known to the writer, which is employed to remove this carbon depends entirely upon the skill of the welder in carrying out the process. There are two general methods of removing the carbon: (1) Flowing iron on the casting and then so manipulating the arc that the newly deposited metal will be flowed out of the weld again, carrying with it the excess carbon; (2) Using a flux that will combine with carbon and then manipulating the arc so as to flow the flux out of the weld.

The avoidance of shrinkage strains in the weld is purely a matter of welding technique. It consists in preparing the joint and depositing the metal in such a way that a string of metal is never fused to cold metal on more than one side. Wherever the string fuses to cold metal on two opposing sides shrinkage strains must result, whether actual rupture occurs or not. Comparatively little trouble results from temperature strains when the arc-welding process is employed on account of the extreme concentration of the heat.

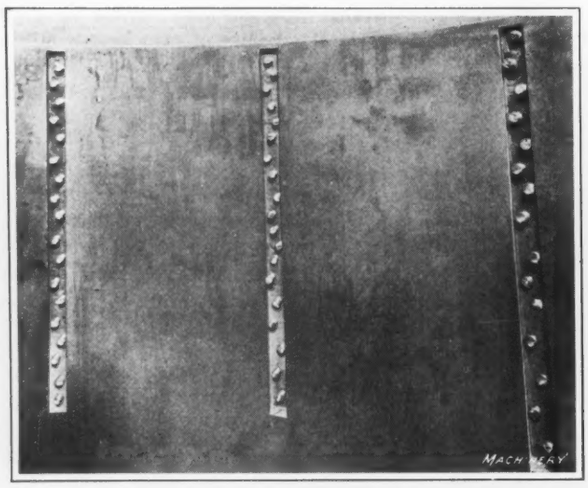


Fig. 3. Chipped-out and Studded Grooves Ready for Welding

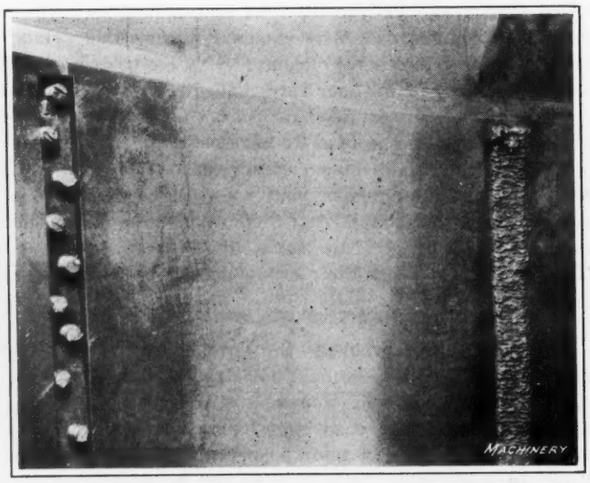


Fig. 4. Groove Ready for Welding and One Completed Weld

A great many cast-iron welds can be made successfully without preheating, but where there is a large amount of welding to be done in a comparatively small area, preheating cannot be avoided if the best results are desired. Those who are familiar with preheating for oxy-acetylene welding should carefully note that preheating for an arc-welding job is different in that it does not require nearly as much heating. For arc welding it is generally sufficient to warm the casting all over so that it is not too hot to touch with the hand. The heating, however, is not anywhere nearly as important as the cooling, and here the greatest care must be exercised.

Having pointed out a few of the difficulties attending cast-iron welding, the best way to visualize them is to take a specific case. For this purpose, a cast-iron job has been selected that is generally considered impossible of successful accomplishment, namely, the welding of the interior surface of a finished engine cylinder. The job here described was done on board a large ship by the Electric Welding Co. of America. No special welding generator or automatic controller was employed. The generator was simply a compound-wound constant-potential 80-volt machine and the control was accomplished by a simple ballast resistor arranged for convenient adjustment of the current. The repairs were made on the second intermediate cylinder of a quadruple expansion engine, which develops 4500 horsepower with a steam pressure of 220 pounds per square inch at normal speed. The cylinder in question, which is shown in Fig. 1, is 56 inches in diameter and approximately 50 inches long. The damage consisted of a number of deep scores and cracks.

Preparing Cylinder for Weld

Preparatory to welding, the scores and cracks were all opened up with a pneumatic chipping hammer so as to expose the full extent of the damage and provide ample space for the deposit of metal. Irregularly spaced holes were then drilled in the surface of the grooves. The portable drill used for this purpose is shown in Fig. 1 on top of the low-pressure cylinder. The holes were next tapped and tap bolts screwed into place. The heads of the bolts were then removed so as to permit the welding pencil or electrode to touch all parts of the work. Several of the parts that were to be repaired are shown in Figs. 2, 3 and 4, studded and ready for welding. The joint and the surrounding metal were slightly warmed with a small blow-torch (seen on the low-pressure cylinder at the left in Fig. 1) before welding.

The welding leads as well as the compressed air pipe were brought on board from the welding company's floating plant, which consists of a power plant to supply electric energy suitable for welding purposes and compressed air for operating air tools such as hammers and drills.

Making the Weld

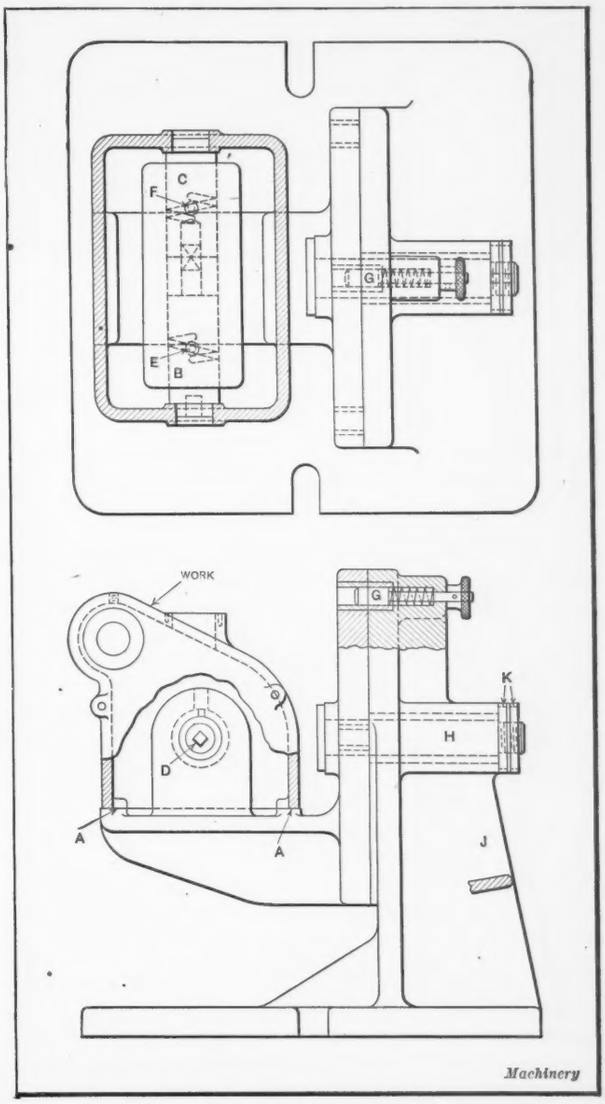
The welding itself was done with a special coated electrode made in the company's laboratories. After the welding patch was completed, as shown at the right in Fig. 4, it was ground to a true contour by means of a portable grinder and a special gage. While using the arc, the valve ports were protected from injury by a metal screen that was hung over two of the cylinder studs.

* * *

INDEXING TAPPING FIXTURE

The indexing fixture here illustrated is intended for use on a radial drilling machine when tapping holes in a casing such as shown mounted in position on the fixture in the illustration. The work is seated on two finished surfaces *A* of the revolvable member of the fixture. A rather interesting method is employed to secure the casing in position. Two plugs *B* and *C* are mounted in a bearing on this revolvable casting, in each of which opposite-hand helical grooves are milled. Holes are drilled in the bearing which supports these plugs, in which the pins *E* and *F* are assembled in such a manner as to engage the opposite-hand grooves. The inner end of one of the plugs has a square stem which fits into a similar square hole in the other plug so that when a socket wrench is fitted into hole *D* and turned, the plugs may be operated simultaneously in opposite directions. By this means the ends of the plugs enter holes in the casing and the shoulders on the plugs are forced against bosses, thus securely holding the work in place.

Another feature of this fixture is the provision for indexing the work. After all the holes have been tapped in the upper side of the work, the fixture is indexed through 90 degrees by withdrawing the spring plunger *G* and turning the revolvable member of the fixture on the center stud *H* which is supported in the base casting *J*. The index holes



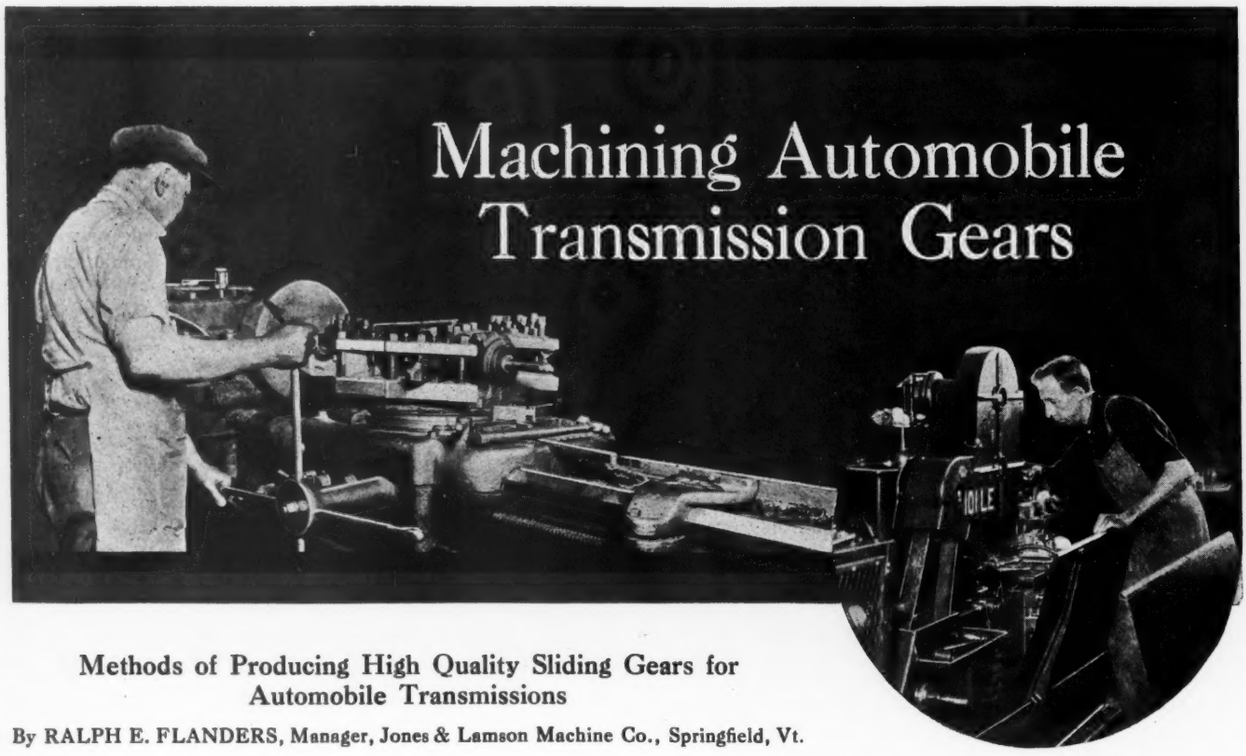
Indexing Fixture used on a Radial Drilling Machine

in which the spring plunger operates are equipped with bushings, as is also the center stud *H*. Two check-nuts *K* are threaded to the center stud, and besides holding the two principal parts of the fixture together, provide means of adjustment for the revolvable member.

This fixture works very successfully when the holes to be tapped are small. Advantage is taken of the radial feature of the machine to reach the various holes. It is understood that a tapping attachment must be employed on the machine and that the fixture is secured to the platen in the regular manner. F. H. M.

* * *

According to a statement issued by the Director General of Railroads, more than $111,000,000 was lost by the railroad administration during November and December on account of the strike of soft-coal miners.



Machining Automobile Transmission Gears

Methods of Producing High Quality Sliding Gears for Automobile Transmissions

By RALPH E. FLANDERS, Manager, Jones & Lamson Machine Co., Springfield, Vt.

THE sliding transmission gears used in most types of automobiles are generally of a simple design; however, as is the case with many other equally simple parts, certain difficulties are presented in their manufacture when it is desired to produce them in large quantities at a low cost and still maintain high quality. The principal difficulties experienced lie in facing the hub and rim true with the broached hole. This condition is essential, as otherwise it is impossible to cut the teeth accurately by means of a gear-cutting machine, because the untrue faces of the gear blanks will cause the arbor of the machine to be sprung when a number of blanks are clamped on it. The purpose of this article is to describe how gears of this nature are produced in an economical and efficient manner.

Types of Holes Generally Used in Transmission Gears

The holes in automobile transmission gears are usually of one of the types illustrated in Fig. 1, square holes having been generally discarded on account of the excessive friction produced when the gears are shifted. In the illustration referred to, each diagram also shows the section of the shaft that corresponds to the particular hole, the inner lines in each case representing the outline of the shaft, while the outer lines represent the hole in the gear. In the diagram shown at *A* the surfaces of the splines on the shaft, of which *D* is the diameter, are a sliding fit in the grooves of the hole. There is a slight clearance between the splines of the hole and the splines of the shaft and a larger amount of clearance between the splines of the hole and the grooves on the shaft. The diameter of the shaft at the grooves is represented by *d*. This type of shaft can be readily machined, and the sliding surfaces can be ground after the shaft is hardened; but there is no way of finishing the sliding surfaces of the hole.

The type of hole illustrated at *B* is considered a better form. In this design, the surfaces of the shaft, of which *d* is the diameter, are a sliding fit on the splines of the hole. There is a clearance between the splines of the hole and the splines on the shaft and between the splines on the shaft and the corresponding grooves of the hole. The clearance between the splines should amount to several thousandths inch, while the clearance between the splines on the shaft and the grooves of the hole may equal as much as 1/32 inch, as this part of the hole is cut by the portion of the broach that wears most rapidly. By allowing this clearance, the broach can be resharpened many times before the clearance becomes too small. This type of shaft may be form-ground, while the hole can also be ground after the part is hardened. It will be noted that in the type of hole shown at *B* it is not necessary to remove as much metal in the broaching operations as in the type shown at *A*.

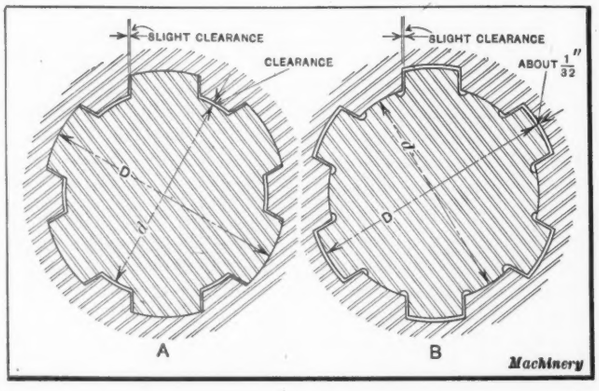


Fig. 1. Types of Holes commonly used in Sliding Transmission Gears

Machining Operations on the Hole and Hub

The first operation on the transmission gear in the method to be described consists of rough-drilling the hole and rough-facing one side of the hub. This operation is performed on a heavy-duty drilling machine. The second operation consists of rough- and finish-boring the hole and finish-facing the side of the hub. A special two-spindle lathe, which is built by the Jones & Lamson Machine Co., Springfield, Vt., is used for the performance of this operation. Fig. 2 shows the gear blanks held by air chucks on a machine of this type and the tools used. There are two steps in the operation, the first consisting of rough-boring the holes with the double-ended rough-boring cutters *B*, which are mounted in the boring-bars *A*; finish-boring the holes by the single-ended cutters *C*, also mounted in the boring-bars *A*; and facing the hubs by tools *D*. Bushings are provided in the chucks for guiding the pilots of the boring-bars. After this step has been completed, the

floating reamers *E* and tools *F* are brought into position for the second step, by a transverse movement of the tool-slide. This step consists of reaming the holes and finish-facing the hubs. This operation is performed very rapidly, as most of the movements are feeding movements; and as two pieces are finished at one time, the production is high. This operation would not be necessary if the gear could be broached with such precision that when mounted on an accurately splined arbor, the hub faced in the first operation would not be more than 0.003 or 0.004 inch out of true. There are few shops, however, that are able to do this commercially.

Broaching the Hole and Milling the Opposite Face of the Hub

The third and fourth operations consist of rough- and finish-broaching the hole in the gear. Care must be taken in these operations to see that the finished hub face has a good bearing on a hardened plate and that this plate is

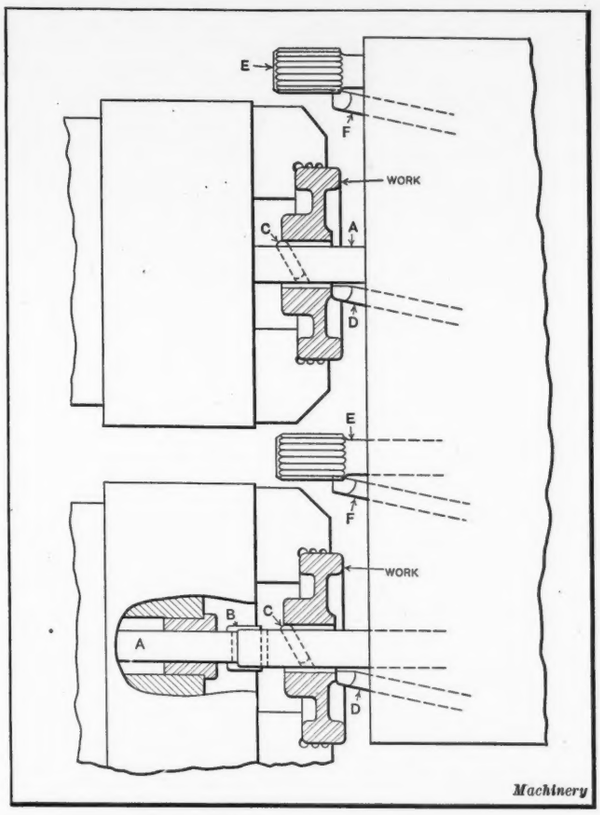


Fig. 2. Tooling Equipment for machining Gear Blanks in a Special Two-spindle Lathe

square with the lines of travel of the broaches. This means that occasional attention must be given to the guides of the machine. In the fifth operation, the unfinished hub face is rough- and finish-faced on a two-spindle heavy-duty drilling machine. The gear is mounted on the fixture shown in Fig. 3, which is first placed beneath the roughing spindle of the machine and then beneath the finishing spindle. The sliding base *A* is so machined as to enable it to be placed beneath both of these spindles. This base supports stud *B* which is milled and ground to be a close but free fit in the splined hole of the work when the work is machined to the minimum tolerance. The hardened grooved washer *C* is provided for seating the work. The upper portion of stud *B* is hardened and ground and serves as a pilot to guide the butt milling cutter *D*, there being a cutter of this type in each spindle of the machine. This cutter is centered on another hardened and ground pilot on the end of the tool shank *E*. The milling cutter and shank are provided with right- and left-hand threads, respectively, to suit the threads in collar *F*, and by this means the depth of cut taken by the cutter can be regulated. The cutter is driven by pin *G*, which is held in a hole in the shank pilot, the threaded end of the milling cutter being slotted to permit the pin to be assembled with the shank, when the cutter and shank are pulled together by collar *F* as the collar is screwed on the two parts. The depth of cut is reached when the rounded end of the pilot on shank *E* comes in contact with the rounded end of the pilot on the stud. This method of regulating the depth of cut is obviously much better than by stopping the descent of the spindle by contact with a collar on the spindle bearing. By having the hub length thus accurately machined, more than one gear blank can be placed on an arbor in succeeding lathe operations, with the assurance that the various surfaces of the gears will always be in the same relative positions.

Rough- and Finish-turning and Facing Operations in Automatic Lathes

The sixth operation consists of rough-turning and rough-facing various surfaces; rough-forming a groove on the hub;

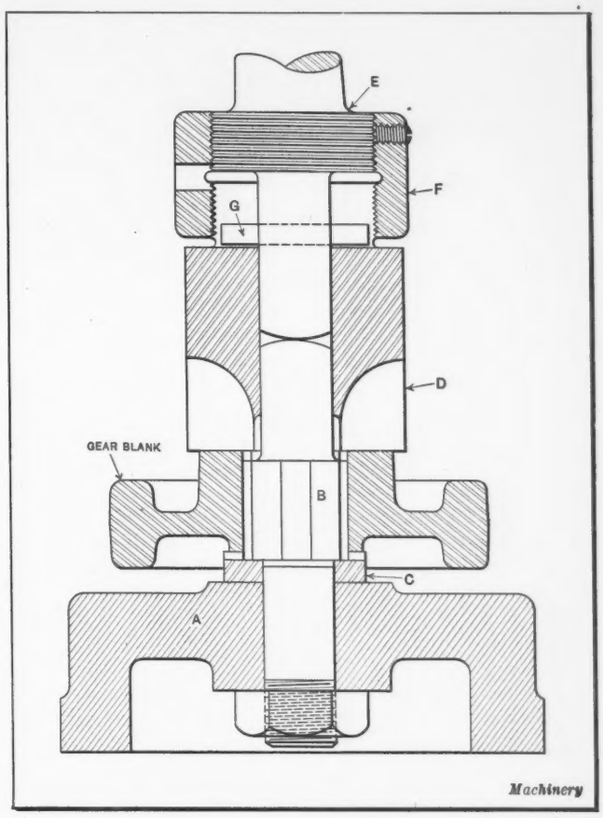


Fig. 3. Fixture and Milling Cutter used in milling Hub Face on a Two-spindle Drilling Machine

and finish-facing one side of the rim. This operation is performed in a Fay automatic lathe which is also manufactured by the Jones & Lamson Machine Co. Three gears are finished on this machine at one time, being held on an arbor as shown in Fig. 4. Two equalizing bushings *A* are placed between the gears so that they may be clamped on the arbor without springing it, if the hub faces are slightly out of true. A detail of one of these bushings is shown in Fig. 6. It will be noted that this bushing has two small flat bearing surfaces diametrically opposite each other on each end, and those on one end are at right angles to those on the other end. The bushing is a loose fit on the arbor, and so can adjust itself to suit the faces of the gear hubs between which it is placed. By this means the extra lathe operation often employed to make the hub face true with the hole is eliminated.

The rear tool-holder, Fig. 4, carries tools *C* which rough-face surfaces *H*, and tools *D* which rough-face surfaces *I* and rough-form grooves *J*. The front carriage travels in two directions, moving first toward the headstock and then radially away from the work. During the first movement, sur-

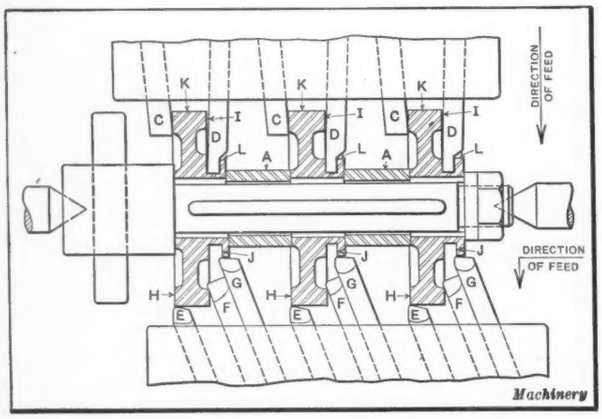


Fig. 4. Lay-out of Tools for machining Gears in a Fay Automatic Lathe, and Method of mounting Gears on Arbor

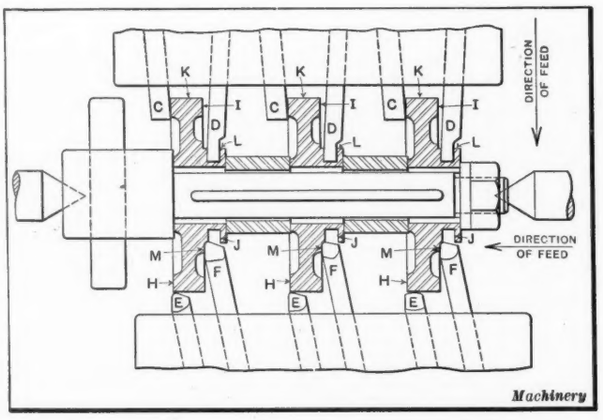


Fig. 5. Tooling Equipment employed to take Finishing Cuts on Gears in Another Fay Automatic Lathe

faces *K* and *L* are rough-turned by tools *E* and *G*, respectively, while during the second movement, surfaces *I* are finish-faced by tools *F*. The tools in the front carriage are engaged in machining the work at the same time as the tools on the rear tool-holder, so that this operation is completed when tools *D* are through machining grooves *J*.

Fig. 5 shows the gear blanks mounted in another Fay automatic lathe for the performance of the seventh operation. This operation consists of finishing all the surfaces roughly machined in the preceding operation. The rear tool-holder is advanced rapidly toward the work until tools *D* reach grooves *J*, which are then finish-formed by these tools, while surfaces *H* are finish-faced by tools *C*. At the same time surfaces *K* are finish-turned by tools *E* and surfaces *L* are finish-turned by tools *F*, which also finish-face surfaces *M*. After surfaces *K*, *L*, and *M* are finished, the carriage is drawn radially slightly away from the work so that the finished surfaces are not scored by the tools as the carriage is returned to its former position. All the cuts in the operation are taken while tools *C* are finish-facing surfaces *H*. The two machines used in the sixth and seventh operations are tended by one operator, and three arbors are provided so that blanks can be clamped on one of these arbors while the operations are being performed on the blanks on the other two, which are mounted on the machines.

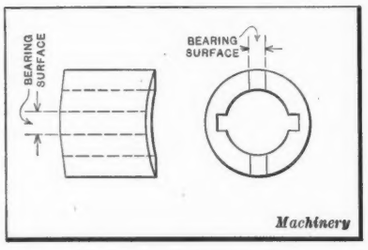


Fig. 6. Detail of Equalizing Bushing

Final Operations on Transmission Gear

The eighth operation consists of cutting the teeth on the gear blank. Fig. 7 shows the method of mounting two blanks at one time on a Fellows gear shaper for this purpose. It will be noted that the blanks are clamped at the rims, this being preferable to the method of clamping at the hubs, because by the former method the work is supported close to the point where the machining occurs, thus permitting heavy cuts to be taken with greater accuracy. Also, when gears are clamped at the hubs and the hubs happen to be slightly out of true, the arbor will be sprung and the teeth will not be cut true with the hole. When the gears are to be clamped together at the rims, they should be so designed that the finished face of the hub is slightly below the finished face of the rim, as shown in the illustration; otherwise, spacers must be placed between the rims so that the hubs do not come in contact with each other and thus prevent clamping at the rims.

The ninth operation consists of rounding the corners of the teeth in a corner-rounding machine. The burrs formed on the gear during the various operations are removed by a tenth operation. The eleventh operation consists of carburizing and heat-treating the gears and removing the scale. In the final operation, the hole is ground on an internal grinding machine, the work being held on a chuck equipped

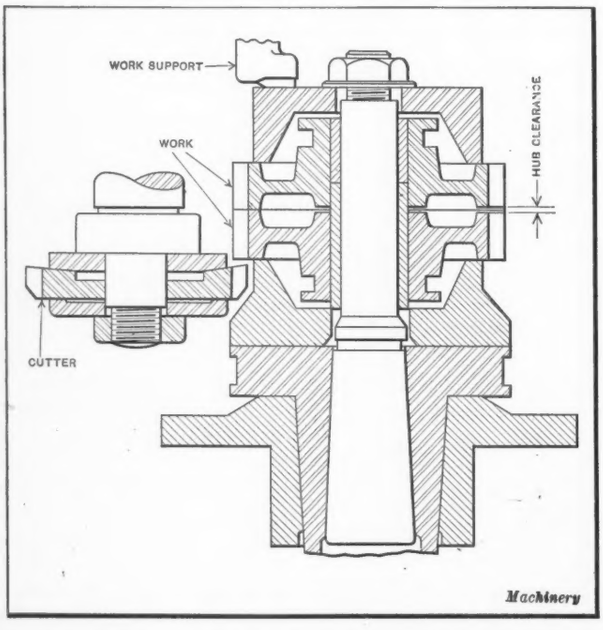


Fig. 7. Method of clamping Gear Blanks on Gear-cutting Machine

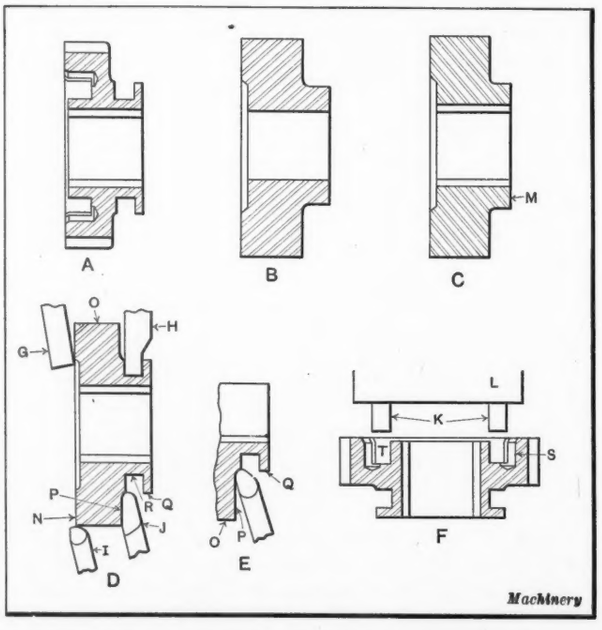


Fig. 8. Methods of machining Other Types of Transmission Gears

with special jaws that grip the work at the roots of the teeth. The gear is also located along the rim instead of at the hub, and the result is a finished hole that is true with the teeth. This is the final important quality necessary for a quiet-running transmission gear.

Machining Another Type of Transmission Gear

Sliding transmission gears may, of course, be of a different design from that just dealt with. For instance, gears used for obtaining the intermediate and high speeds are often of the type shown at *A*, Fig. 8. Holes are drilled in one side of this gear and a recess is cut in the same side, thus forming an internal clutch. The method of manufacturing this gear is very similar to that previously described, so that only a condensed description will be given. Fourteen operations are required, which are performed in the following order: (1) The hole is drilled in the blank, this operation being performed on a drilling machine. (2) The hole is rough- and finish-bored and a recess is machined on one side of the blank as shown at *B*, a special two-spindle lathe of the type shown in Fig. 2 being used for this purpose. (3) The hole is rough-broached. (4) The hole is finish-broached. (5) Surface *M*, on the detail shown at *C*, is rough- and finish-faced on a two-spindle drilling machine, the work being mounted on a fixture of the type illustrated in Fig. 3 and machined by similar tools. (6) This operation is performed in a Fay automatic lathe, the work being mounted on an arbor in the manner illustrated in Fig. 4. The various surfaces machined in this operation and the tools used are shown at *D* in Fig. 8. Surface *N* is rough-faced by tool *G*, and groove *R* is rough-formed by *H*, these tools being mounted on the rear tool-holder. Surface *O* is rough-turned by tool *I*; surface *Q* is rough-turned by tool *J*; and surface *P* is rough-faced by tool *J*, these tools being mounted on the front carriage. When surface *P* is very wide, tool *J* should be of the type shown at *E*, which necessitates that the carriage be moved radially away from the work after surfaces *O* and *Q* are machined, in order to face surface *P*. (7) Finishing cuts are taken on all the surfaces roughly machined in the sixth operation. (8) The teeth are cut on the rim by a gear-cutting machine. (9) The corners of the teeth are rounded in a corner-rounding machine. (10) Holes *S*, in the detail shown at *F*, are drilled and countersunk on a multiple-spindle drilling machine. (11) Recess *T* is machined on a drilling machine, the work being held on a fixture of a similar design to that illustrated in Fig. 3. The recess is cut by cutters *K* which are inserted in the cutter-head *L*. (12) The burrs formed in the various operations are removed from the work. (13) The gear is carburized and heat-treated and the scale is removed. (14) The hole is ground on an internal grinding machine.

* * *

AMERICAN ENGINEERING STANDARDS COMMITTEE

After almost three years of investigation and discussion by engineering societies, the revised constitution of the American Engineering Standards Committee has been adopted, and has been ratified by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, and the three Government Departments, of Commerce, Navy and War. Each of these interests have three representatives, and the committee as it exists today consists of twenty-four members. A. A. Stevenson, the newly elected chairman, is a past-president of the American Society for Testing Materials, and has been officially and actively interested in standardization work for many years. Dr. P. G. Agnew, formerly of the United States Bureau of Standards, is permanent secretary, with headquarters at the Engineering Societies Building, 29 W. 39th St., New York City.

The American Engineering Standards Committee will make it possible to give an international status to approved American engineering standards and to cooperate with kindred organizations in other countries. Similar organizations are now functioning in Great Britain, France, Switzerland, Holland, and Canada. Through the new committee the methods of arriving at engineering standards will be unified and simplified, and, by cooperation, the duplication of standardization work will be prevented. Standards will not be created without giving all interested an opportunity to participate. The approval of a standard by the American Engineering Standards Committee does not mean that the committee has itself worked out and approved each detail, but rather that the work has been carried out by a sectional committee adequately representing the industry concerned, and sponsored by one or more bodies of ability and experience, so that the result may stand for what is best in American engineering practice.

What the Committee is Doing

The American Engineering Standards Committee has already made considerable practical headway. It has approved specifications for standard pipe threads, for which the American Society of Mechanical Engineers and the American Gas Association are sponsors, and is representing America on this subject at an international conference in Paris. Cooperation is in progress with the National Screw Thread Commission, authorized by Congress and composed of representatives of the various technical societies, looking forward to standard screw threads. Through this arrangement, direct cooperation with the British, which is not possible by the official commission, is being carried out. The committee is also in active cooperation with the Canadians on bridge specifications, with the British on specifications for machine tools, and with the Swiss on ball bearings.

A large conference, in which practically all national organizations interested in industrial safety participated, has unanimously voted that all industrial safety codes should be prepared under the auspices of the American Engineering Standards Committee.

How the Committee Operates

Any organization may request the committee to approve standards that it has formulated, or to approve committees that it has appointed, and by so doing becomes a sponsor society. Two or more organizations may act as joint sponsors. Approval of a standard is given when it is the substantially unanimous conclusion of a section committee made up of representatives of producers, consumers, and general interests, and so selected that all interests concerned have adequate representation on the section committee. It is understood that a standard must be referred to as that of the sponsor, using whatever title the sponsor has given it, followed by the words "Approved by the American Engineering Standards Committee." The approval may be given in one of three ways: "Recommended Practice," Tentative Standard," or "American Standard."

Any standard or group of standards adopted by any organization or in process of preparation, prior to January 1, 1920, may be approved by the committee, if in the opinion of the committee, it has either been developed by a properly constituted committee, or has, by actual practice, proved its right to become a standard. In addition to assisting in the selection of committees and certifying that their work has been done under proper conditions, the committee will act as a bureau of information regarding standardization. It will collect information regarding existing standards and the bodies that have formulated or adopted them. This will enable it to properly give the data to those who select a committee to formulate a new standard or revise an old one. Provision is made for direct representation on the American Engineering Standards Committee, of additional organizations interested in engineering standardization.

INSPECTION OF A TRIPLE-TAPERED CHAMBER CHECK

By V. E. AYRE

As explained in an article "Inspection of Tapered Plugs" in the February number of MACHINERY, the different tapers may be determined by taking micrometer readings over wires of equal size, placed at different intervals on the tapered plug. In the diagram of the 30-caliber chamber check, Fig. 1, the angle a may be determined accurately by wire measurements, since the distance H on the check is greater than one inch; but it is rather difficult to determine

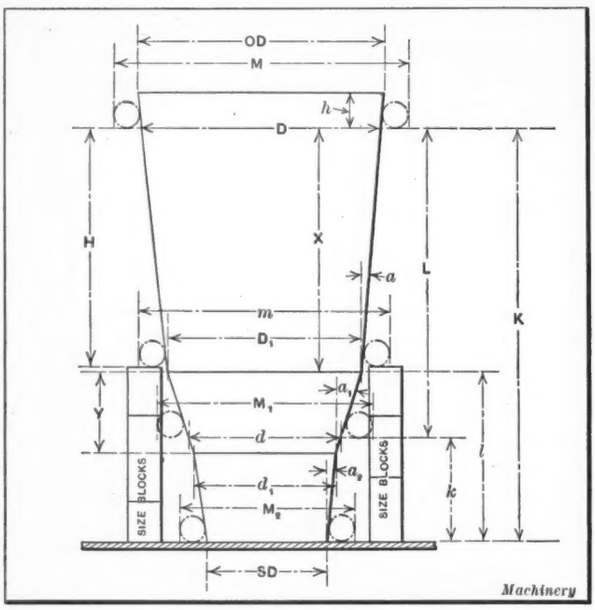


Fig. 1. Diagram illustrating Application of Formulas for measuring Triple-tapered Plugs

accurately the values of angles a_1 and a_2 by taking measurements over wires at different intervals, owing to the fact that the lengths of the short tapers are so short that only differences amounting to a small fraction of an inch can be obtained between any two micrometer readings taken over these tapers. When taking micrometer readings over wires on a plug that has a very slight taper the wires should be lightly weighted in order to keep them from rising so that they will make the proper contact with the plug as the pressure is brought to bear on them by the micrometer spindle.

Referring to Fig. 1,

$$T = \frac{M - m}{H} = \text{long taper per inch}$$

$$\text{Tan } a = \frac{T}{2}$$

If so desired, angles a_1 and a_2 may be similarly determined, or they may be determined by means of a V-block and sine bar, after the angle a has been found. When using the sine bar, clamp the gage in a V-block and align it properly on a mounted sine bar, as shown in Fig. 2. Then adjust the sine bar until the element E is parallel with the surface plate. Measure the resulting angle $2a + b$. Then by subtracting one-half the angle of taper T, the angle that the center line of the gage makes with the sine bar (or the angle that the sine bar makes with the surface plate when the center line of the gage is parallel with the surface plate) is equal to $2a + b - a$, or $a + b$.

Having found this angle $a + b$, which may be called the angle of correction, the angles a_1 and a_2 can be quickly determined as follows: Relocate the sine bar first so that element E_1 and then so that element E_2 will be parallel with the surface plate. Measure the angle between the sine bar and the surface plate while the gage is in each of these positions, and from each measurement thus made subtract the angle of correction $a + b$ and the remainders will be the values of angles a_1 and a_2 respectively. These angles a_1 and a_2 may also be determined by the method described in the February number.

Having determined the size of angles a_1 and a_2 the corresponding tapers may be expressed by the equations

$2 \tan a_1 = T_1 =$ intermediate taper

$2 \tan a_2 = T_2 =$ taper at small end

After the angles of taper are determined, proceed to find the dimensions of the plug. To find the corrections which are to be subtracted from the various micrometer readings over the wires in order that the diameter of the plug at any given height may be determined, apply the following formulas as given in the February number of MACHINERY, in the article previously referred to.

$C = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a)]$ = correction for taper T

$C_1 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_1)]$ = correction for intermediate taper T_1

$C_2 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_2)]$ = correction for third taper T_2

The diameters at heights K, k, and at the small end of the gage, Fig. 1, may then be expressed by the following equations:

$D = M - C =$ diameter of plug at distance K from small end

$d = M_1 - C_1 =$ diameter of plug at distance k from small end

$SD = M_2 - C_2 =$ diameter of plug at small end

$OD = D + hT =$ diameter at top

To determine the diameters at the intersection of the tapers, use the general formula given in the article "Intersection of Tapers" in the February number of MACHINERY:

$$X = \frac{T_1 L - (D - d)}{T_1 - T}$$

Therefore, the diameter at the intersection of the first and intermediate tapers equals

$$D_1 = d + T_1\,(L - X), \text{ or } D - TX$$

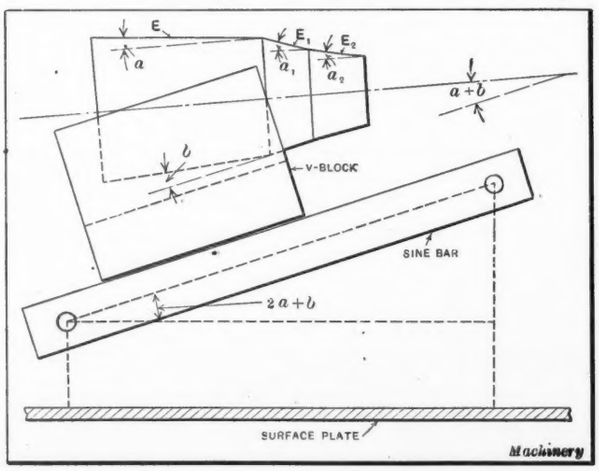


Fig. 2. Method of using Sine Bar when measuring Angles of Taper on Plugs

Again, applying an adaptation of the general formula for intersection of tapers,

$$Y = \frac{(D_1 - SD) - T_2 l}{T_1 - T_2}$$

Using a similar method to that employed for determining diameter D_1, the diameter at the intersection of the intermediate and third tapers equals

$$d_1 = D_1 - T_1 Y, \text{ or } SD + T_2\,(l - Y)$$

It is evident that

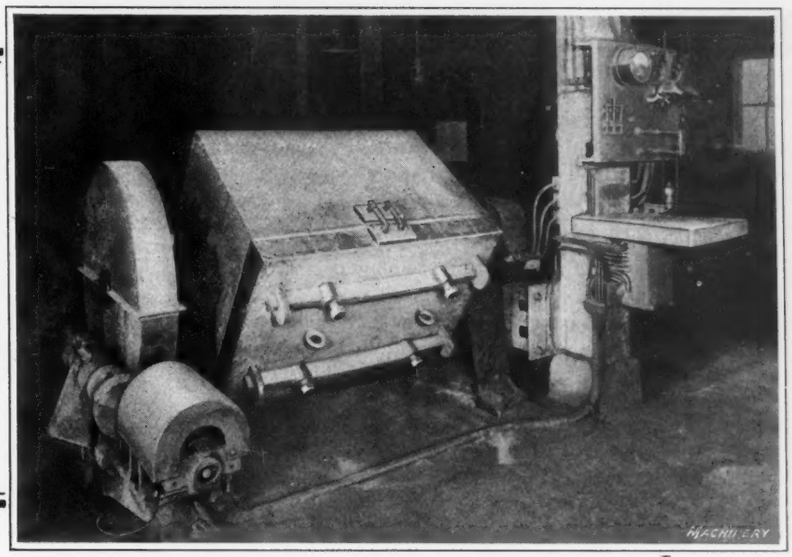
$L = K - k =$ distance between the diameters D and d

$l = K - X =$ distance between the diameters SD and D

$X + h =$ distance from top to intersection of first and intermediate tapers.

Electro Sherardizing

Application of a Rustproof Coating to Miscellaneous Products Including Sheet Metal



PREVIOUS articles on sherardizing, which have been published in MACHINERY, have explained the method of conducting this process in furnaces heated by the combustion of gas, coke, or some other fuel. An improved type of sherardizing equipment has been developed by the General Electric Co., in which the heat is generated by passing electric current through suitable windings. In the following article a discussion will be presented of results obtained from the use of machines of this type, with especial reference to the practice of the Wise Electro Sherardizing Co., of Detroit, Mich.

Sherardizing is one of three commonly used methods of applying metallic zinc to iron and steel products, in order to provide a rustproof coating. Of the various methods which are used to protect iron from corroding or rusting, the application of a zinc surface is one of the most effective. This is due to the fact that zinc is one of the few moderate-priced metals which is electro-positive to iron. To understand the meaning of this statement, it is necessary to know what takes place during the corrosion of a piece of iron or steel that is protected by a coating of some other metal. The corrosive action is started by the setting up of a galvanic electric current which results in carrying metal to the negative pole of the electrolytic cell.

In the case of zinc, which is electro-positive to iron, a galvanic action of this kind causes a slight depletion of the zinc at points where such an action is proceeding, but does not damage the iron. With iron or steel products covered with a coating of some metal which is electro-negative to iron, the result of such a galvanic action would be the reverse; namely, there would be a depletion of the iron beneath the coating of the second metal which covers the work. It is of interest to note that the corrosive action caused by a galvanic current can only take place where there is a flaw in the coating of zinc or other metal with which the iron is covered, that allows moisture to gather. But as it is practically impossible to produce a coating in which there are not at least a few very small openings, the effect of the galvanic action which takes place at such points becomes a matter of importance.

Methods of Applying Zinc Coatings to Iron Products

There are three methods by which a rustproof coating of zinc may be applied to iron and steel products; namely, by hot galvanizing, zinc plating, and sherardizing. Hot galvanizing is the first of these methods and is the one most generally used. It possesses certain noteworthy advantages in rustproofing large work, of which tanks, buckets, sheet metal, etc., are typical examples; but with the exception of sheet metal and wire, that can be wiped after dipping in the molten metal, the coat of zinc applied by this method is rough and uneven in thickness. Owing to this lack of uniformity, it is found impracticable to galvanize threaded parts which must be assembled together, or other machined work where close limits of tolerance are demanded. Furthermore, it is necessary for the work to be thoroughly cleaned before galvanizing, because if this precaution is not taken, there will be a tendency for the coating of zinc to peel off the iron, and thus expose it to corrosive action.

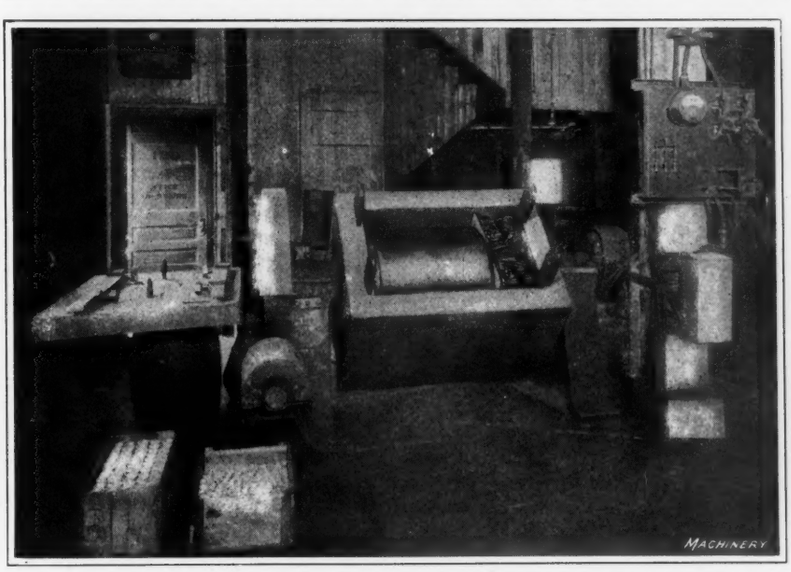


Fig. 1. Electro-sherardizing Machine with Cover removed, showing Method of packing Two Kinds of Work in Drum

Where a practice is made of zinc-plating the work, a smooth coating of good appearance is obtained. This method can be used on heat-treated parts, owing to the fact that it is applied without requiring the temperature of the work to be raised. Also, the thickness of the coating can be accurately controlled, so that zinc plating may be used in cases where close limits of tolerance must be maintained on machined work. As in the case of pieces to be galvanized, the work must be thoroughly cleaned before plating, because the presence of any foreign matter will cause the coating of zinc to peel off. A further limitation of zinc-plated work is that it will not stand temperatures above 300 degrees F.

without peeling; and as in the case of all electrolytic processes, it will be found that there is a tendency for the thickness of the deposit to lack uniformity, being heavy on the high spots of the work and lighter in the depressions and under shoulders. This tendency is particularly noticeable in the case of threaded work, the deposit being heavy at the tops of the threads and light at the roots.

Application of Rustproof Zinc Coating by the Sherardizing Process

Sherardizing is the third method of applying a protective zinc coating to which reference has been made previously. This process possesses many important advantages which should commend it to the attention of manufacturers of metal products. The application of a zinc coating by this method is dependent upon the property of zinc which causes it to vaporize through the application of heat. The sherardizing operation is carried on by packing the work in a sealed drum with a suitable quantity of zinc dust, after which the temperature is raised so that the zinc is transformed into a vaporous condition, in which state it is able to penetrate beneath the surface of the work. It will be evident to all experienced mechanics that there is a distinct analogy between this method of applying zinc and the familiar process of carburizing steel products which are to be case-hardened. Three noteworthy features of the service obtained by sherardizing are that the zinc is firmly bonded to the iron, that the thickness of the rustproof coating can be accurately controlled, and that the zinc deposit is of uniform thickness and is deposited to an equal degree on both flat surfaces and corners of the work.

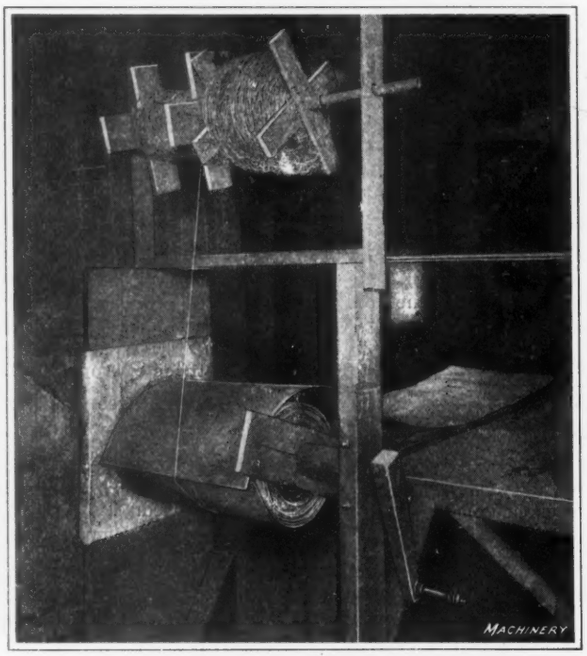


Fig. 2. Method of winding Sheet Metal into Rolls for sherardizing with Wire Separator interposed in order to provide Space for the Zinc to enter between Adjacent Sheets

The tendency for the zinc to be firmly bonded to the metal is due to the fact that at the time when the process is started, the zinc vapor or particles of zinc dust find their way into the pores of the steel, and create a firm anchorage to which the zinc coating is connected. The photomicrograph of a cross-section of the zinc coating shows that there is a porous area between the iron and the more dense outer coating of zinc, and this condition is believed to be distinctly beneficial. It is a matter of general knowledge that sherardized products can be bent, swaged, and subjected to other treatments with the metal cold, without showing any tendency for the zinc to crack or flake off; and this is explained on the assumption that this porous structure of the lower surfaces of the zinc acts as a cushion between the zinc and the iron, thus enabling such operations to be performed without damaging the coating of zinc.

Thickness of the Zinc Coating

There is a definite relation between the temperature at which the sherardizing operation is performed and the thickness of the zinc coating which is obtained. Knowing this relationship, it is an easy matter to obtain a layer of zinc of the desired thickness. For practical purposes, the zinc is from 0.002 to 0.0025 inch in thickness, and attention is drawn to the fact that the coating should be at least up to the lower of these limits in order to assure rustproofing the work. The possibility of regulating the thickness of the zinc coating, and the assurance that this coating will be of uniform thickness all over the work, enables machined products requiring close limits of tolerance to be sherardized with successful results.

For instance, consider the case of bolts and nuts which are to be assembled together, and where the service to which they are subjected is of such a nature that the steel is likely to be damaged by corrosion. Knowing the thickness of the zinc coating which it is desirable to apply, it is merely necessary for the shop drawing to specify reducing the diameter of the bolt and increasing the diameter of the nut to such an extent that the coating of zinc will bring the dimensions of these two parts back to a point where they will assemble together properly. The same plan can be applied in sherardizing a great variety of other finished parts where accuracy is essential. In addition to its use for applying a rough coating of zinc to protect the work from damage caused by atmospheric conditions, sherardizing may be employed to apply a highly finished surface to the work. Where this result is desired, a practice is made of first polishing the surface of the work with a wheel faced with emery, and then polishing with a rag wheel after the sherardizing operation has been performed, with the result that a finish is produced that is equal in appearance to a good nickel-plated surface.

To obtain successful results in sherardizing, there are three variable factors which must be controlled, namely, the temperature, the time during which the work is exposed to the action of the zinc, and the purity of the zinc dust that is used. In so far as the last two variables are concerned, there is very little difference between the electro-sherardizing process developed by the General Electric Co. and the methods which have been discussed in previous articles in MACHINERY, where the heat for conducting the process is supplied by the combustion of gas, coal, or some other fuel. However, where heat is supplied by electric power, there is a marked advantage in regard to accurate regulation of the temperature, which, in turn, is the means of regulating the thickness of the deposit that is applied to the work, and in certain cases, the uniformity of thickness of the zinc coating applied at different points on the same piece of work. Electric power has the further advantage of being cleaner and affording greater convenience of operation. As regards the zinc dust factor, it may be mentioned that the dust which is used consists of finely subdivided metallic zinc and zinc oxide. This material can be used over and over again, but a practice is made of adding about 10 per cent of fresh zinc to a previously used charge. Experience has shown that this practice is the means of maintaining the purity of the zinc dust at the required level to give satisfactory results.

Cleaning Work Preparatory to Sherardizing

In order for the sherardizing operation to be performed with satisfactory results, it is necessary to have the work clean before it is subjected to the action of the zinc. However, it may be mentioned in this connection, that the same absolute degree of cleanliness is not required as in the case of electroplating and certain other methods of applying metallic finishes to metal products. For sherardizing, the usual practice is to employ a sand blast or shot blast to remove heavy coatings of rust, fire scale, etc., while the work is washed in a solution of caustic or some similar chemical to provide for the removal of thick coatings of grease.

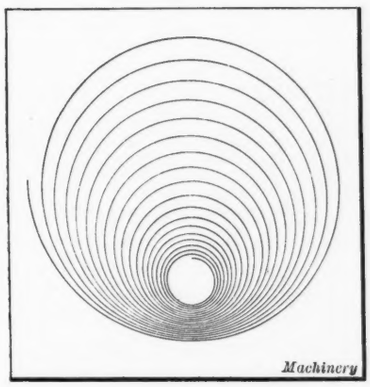


Fig. 3. Diagram showing how Zinc is able to penetrate between Sheets in a Roll

The Wise Electro Sherardizing Co. prefers the use of a 16 per cent solution of sulphuric acid for the removal of fire scale, instead of employing a sand blast. The work is first immersed in a wooden vat of this acid for about ten minutes and then thoroughly rinsed in water to prevent further action of the acid. Before leaving this discussion of cleaning, it is important to note that the presence of a very thin film of grease or a light coating of freshly formed rust, does not present an insurmountable difficulty to the successful performance of the sherardizing operation, as it would to the attainment of satisfactory results in electroplating, etc. When there is grease on the work, it is vaporized by the heat of the sherardizing drum before the zinc begins to attack the work, and so causes no trouble. Likewise, a thin film of fresh rust does not cause any trouble, as the zinc is able to readily penetrate into the pure iron beneath it.

General Electric Sherardizing Equipment

Two sizes of sherardizing equipments are built by the General Electric Co., one of which has a drum 24 by 24 by 40 inches in the compartment in which the work and zinc dust are packed. The other machine has a drum measuring 10 by 10 by 17 inches. In operating either of these equipments it is found that the process of sherardizing proceeds most favorably when the temperature is raised to 340 degrees C. (644 degrees F.) as rapidly as possible. For operating the large sherardizing machine, the current consumption is 53.5 kilowatts to bring the drum and its contents up to the sherardizing temperature, after which the current consumption is 13.5 kilowatts. For the smaller machine, 15 kilowatts are required to bring the drum and work up to the sherardizing temperature, after which 5 kilowatts will maintain the operating temperature. Reference to the heading illustration and Fig. 1, which show one of the large sized sherardizing machines in operation at the plant of the Wise Electro Sherardizing Co., will show that the drum in which the work is packed is supported by trunnion bearings, and that there is an electric motor which provides for revolving the drum by means of a worm and wheel through which the power is transmitted.

Contained in all four sides and both ends of the drum there are electric windings through which the power is transmitted to heat the drum and work; and outside of the windings there is placed a packing of heat-insulating material which retains the temperature at the desired degree. At one end of the machine there are three slip rings and carbon brushes which take electric power from the line and transmit it through the windings in the machine. These windings are so arranged that power may be taken from a direct-current line or from a single-phase alternating-current line of any standard voltage. There is a double switch provided for making connection with the electric windings, and in starting the sherardizing operation, this switch is first thrown into a position which transmits the maximum amount of power through the windings to provide for bringing the temperature up to normal as rapidly as possible.

It usually takes four hours to heat the contents of one of the large sized drums to this temperature. When this result has been obtained, as indicated by a thermometer made by the Taylor Instrument Companies, of Rochester, N. Y., which is attached to the side of the drum and projects inward to come into intimate contact with the contents, the electric switch is thrown into its second position, which delivers a sufficient quantity of power through the windings so that the temperature of the work may be maintained at 340 degrees C. (644 degrees F.) for the period of four hours which is required to give the average depth of zinc that is desired on the work. In order that the process may proceed satisfactorily, it is important that there shall not be a greater temperature fluctuation than ± 5 degrees F. and if the operator of the machine finds that this limit of variation has been exceeded, he immediately makes an adjustment of the regulator to bring the temperature back within its normal range. When the sherardizing has been completed, the work is left in the drum to cool after the current has been shut off, and about three and one-half hours are required to allow the temperature to drop to 230 degrees C. (446 degrees F.)

Method of Sherardizing Steel Plates

There are numerous instances in which it would be found advantageous to apply a rustproof coating of zinc to steel plates by means of the sherardizing process. The bonding which is secured between the zinc and the iron by this method is especially advantageous in the case of plates which are later to be bent or otherwise changed in form, because it prevents the zinc from flaking off. Early attempts which were made to sherardize plates were unsuccessful, difficulty being experienced in securing a uniform deposit of zinc over the entire surface of the work. This trouble was chiefly due to the fact that where large areas had to be covered, it was difficult to so support the work that the entire surface of the steel or iron would be exposed to the zinc. One customer of the Wise Electro Sherardizing Co. engaged in the manufacture of gas ranges was anxious to obtain rustproof plates for oven linings, and the problem of developing a method of sherardizing plates for this purpose was referred to this company. Owing to the restricted size of the drums in which the sherardizing process is conducted, it was necessary to take the plates and roll them up in order to enable a sufficient quantity of work to be put into the drum at a time to avoid making the cost of sherardizing prohibitive.

Acting upon this method of procedure, it was then necessary to devise some means of separating adjacent sheets of metal in the roll, in order to prevent having them lie so closely together that it would be impossible for the zinc dust and zinc vapor to reach all portions of the surface of each sheet. After considering various expedients, it was

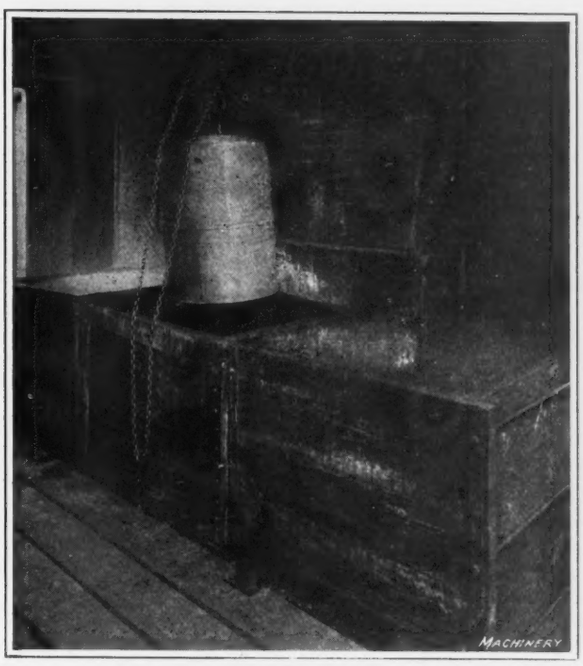


Fig. 4. For pickling, Rolls of Sheet Metal are held vertically to prevent Tendency of Sheets to exclude Acid at One Side of Roll

found that the most satisfactory way of obtaining the desired result was to roll up the sheets of steel as shown in Fig. 2, with a single strand of ordinary 15-gage wire between adjacent sheets. This method of rolling is quite simply accomplished by running the sheets of steel over a bench to the winding reel, and having a reel of wire suspended from the ceiling over the reel on which the roll of steel is to be wound. With such an arrangement, it is found that ample space is provided to allow the zinc to penetrate, particularly in view of the fact that the drum in which the sherardizing operation is performed is kept constantly revolving and there is a tendency for the coil of steel to assume a position similar to that shown diagrammatically in Fig. 3. Here it will be seen that at the lower side of the coil, adjacent sheets of steel are as closely in contact with each other as they are able to come with the strand of wire between them, but at the upper side there is considerable space between adjacent sheets. As the drum revolves, the position of that part of the coil is constantly shifting, where the sheets are sufficiently separated to allow the zinc to penetrate, thus allowing all portions of every sheet in the coil to be coated with zinc.

Packing Different Types of Work for Sherardizing

It will frequently happen that it is necessary to run several different classes of work in the same drum. The need of such a practice will at once be apparent when it is remembered that a period of about twelve hours is required to load the drum, bring the work up to the operating temperature, complete the sherardizing process, and cool the drum down again to a point where the work can be removed. Special means must be provided to efficiently handle different classes of work in the same drum during a single run, and this is particularly true in cases where some of the work is threaded or otherwise of a nature that would be readily damaged if allowed to tumble in contact with other work that is being heated at the same time. To protect pieces of this kind while sherardizing, a practice is made of providing separate containers in which different classes of work are placed, and then having these containers supplied with individual charges of zinc dust and placed in the drum of the sherardizing machine. A general idea of the way in which this practice is conducted will be gathered from Fig. 1, which shows a roll of sheet metal in one end of the drum and the remaining space filled with a metal box containing eyebolts. Before leaving the subject of sherardizing plates, attention is directed to Fig. 4, which shows a coil of sheet metal about to be dipped into the sulphuric acid pickling bath. It will be seen that this coil is suspended endwise, which is an important matter, because if it were held with the axis of the cylinder horizontal, there would be a tendency for one side of the plates to press tightly against the other, as indicated in Fig. 3, excluding the acid and thus preventing the accomplishment of a complete cleaning of the work.

In order to test the perfection of a sherardized surface as regards its ability to resist rust and corrosion, the recommended practice is to spray the work with a solution of salt and water, which is made of such a strength that it has a specific gravity of from 1.026 to 1.030 at a temperature of 60 degrees F. The test samples are placed on a rack in a covered box, and a constant spray of brine, atomized by compressed air, is kept playing inside of the box, care being taken not to allow the spray to impinge directly upon the work. Under such conditions, the pieces to be tested are constantly covered with a very thin film of moisture over their entire surface, but there should be very few drops of any appreciable size on the work. This test is a very searching one and reveals any minute holes or uncovered areas on the metal, and thus affords an opportunity of determining the degree of protection against rust which has been provided by the sherardizing operation. When pieces have been properly treated according to the method of sherardizing described in this article, they should be able to stand at least 100 hours of the salt spray and show no evidence of rust or corrosion.

Fig. 5. Sherardized Products may be given a High Finish, Comparable with Results obtained by the Nickel-plating Process

Limitations of the Sherardizing Process

Sherardizing possesses a great many noteworthy advantages over other methods of applying a rustproof coating of zinc to iron or steel products, but despite this fact it has not come into very general use. This fact is especially remarkable when the high cost of copper and other constituents which are required to make brass are taken into consideration. Iron and steel have been freely used as substitutes for these rustproof metals, and they have had to be protected from the atmosphere in order to enable such a substitution to be made with successful results. Sherardizing has been successfully used for the purpose and has given very satisfactory results in practically all cases.

That the process has not come into extremely general use is due to limitations of the equipments which are at present available for performing sherardizing operations, and not to any deficiencies of the results obtained from this method of rustproofing. For one thing, the equipments which are at present built do not make it possible to sherardize large pieces of work; and even in cases where a few pieces would go into the drum, the extended period of time required to complete the operation would not allow such large pieces to be rustproofed by this method at anything but a prohibitive cost. It may also be mentioned that the process is not well adapted for rustproofing parts which have been heat-treated, if they have been subsequently drawn at a temperature below 650 degrees F. If an attempt is made to sherardize such parts, it is found that the temper of the work will be changed. These difficulties are not insurmountable and will doubtless be successfully overcome. Their elimination would mean a considerable increase in the quantity of work sherardized.

* * *

The great Krupp works at Essen, Germany, which previous to the war employed 81,000 men, are now employing 85,000 men on peace-time production. The plants are now manufacturing a variety of machinery and tools including Diesel engines, steam engines, locomotives, railway cars, cream separators, small tools and screw machine products.

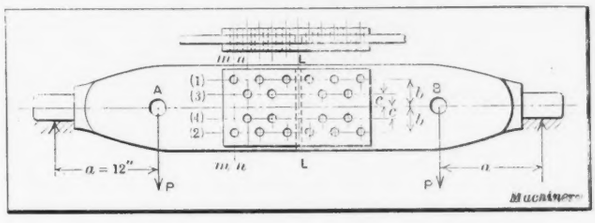
SPLICING LOCOMOTIVE BRAKE BEAMS

By VICTOR M. SUMMA
Engineering Examiner, American Brake Co., St. Louis, Mo.

In order to simplify assembling, the brake beams of locomotives are sometimes made up of two pieces connected at the middle. As the connection admits of no cover plates, an ordinary butt-joint such as shown in the accompanying illustration is used in making the splice. It is, of course, necessary to ascertain the thickness of the splice plates and the diameter of the bolts that will produce a joint as strong as the rest of the brake beam. Let us assume that the flat portion of the brake beam is 9 inches by 1 inch and that the load P at the pins A and B is 18,000 pounds, 12 inches from each journal bearing center. Since the bending moment is constant and a maximum between A and B, the stress at any section of the beam between these pins is

$$\frac{18{,}000 \times 12}{\frac{1 \times 9^2}{6}} = 16{,}000 \text{ pounds per square inch in tension}$$

and compression, and the stress in any of the parts of the splice should therefore not exceed three-fourths of this figure or 12,000 pounds in shear and not more than twice this shear or 24,000 pounds as bearing or crushing pressure. Applying the theory of the beam to the bolts or rivets, it is clear that the strain in each bolt section is directly proportional to its distance from the neutral axis A–B of the beam. So that if Q represents the amount of strain in a bolt which we may imagine to be located at a unit distance from line A–B, the strain on the bolts in the rows (1) and (2) will be $Q \times b$, and that on the bolts in rows (3) and (4) will be $Q \times c$.



Butt Joint employed in splicing Locomotive Brake Beams

Also it is obvious that the external moment Pa on the beam must be equal to the sum of the moments of the strains (or forces) in all the bolts on one side of the center line L–L, about the points of intersection of lines m–m, n–n, etc., and the neutral axis A–B. In other words, we must have

$$Pa = 6Qb \times b + 4Qc \times c$$
$$Pa = Q\,(6b^2 + 4c^2)$$

Therefore

$$Q = \frac{Pa}{6b^2 + 4c^2} = \text{strain in a bolt at a unit distance from line } A\text{–}B. \text{ Or}$$

$$\text{Stress in bolts in rows (1) and (2)} = Qb = \frac{Pa}{6b^2 + 4c^2} \times b$$

$$\text{Stress in bolts in rows (3) and (4)} = Qc = \frac{Pa}{6b^2 + 4c^2} \times c$$

The above expressed as a rule, is as follows: To find the total stress in any bolt of a splice of the type shown in the illustration, divide the bending moment Pa on the brake beam by the sum of the squares of the distances from the neutral axis *of the beam* of all the bolts *on one side* of the center line L–L, and multiply the result by the distance to the axis A–B of the bolt under consideration.

Now assuming that $b = 3$ inches and $c = 1\frac{1}{2}$ inches, we have by substitution in the above formulas:

$$Qb = \frac{18{,}000 \times 12}{6 \times 3^2 + 4 \times 1.5^2} \times 3 = 3428.57 \times 3 = 10{,}286 \text{ pounds}$$

$$Qc = 3428.57 \times 1.5 = 5143 \text{ pounds.}$$

Or, since by assumption the unit stress in shear must not exceed 12,000 pounds per square inch, the diameter of the bolts in the outside rows can be found thus (the bolts being in double shear):

$$2 \times 0.7854D^2 \times 12{,}000 = 10{,}286$$

Therefore

$$D = \sqrt{\frac{10{,}286}{2 \times 0.7854 \times 12{,}000}} = 0.738 \text{ or, say, } \tfrac{3}{4} \text{ inch}$$

The diameter of the bolts in the inside rows will be found likewise:

$$D' = \sqrt{\frac{5143}{2 \times 0.7854 \times 12{,}000}} = 0.525 \text{ or say, } 9/16 \text{ inch}$$

But for practical reasons the bolts are all made of the same size, and so the required diameter is $\frac{3}{4}$ inch.

In considering the size of the splice plates, it is clear that the material of the plates in contact with half of the bolt shanks will be crushed if it cannot withstand the 10,286-pound load. For each bolt there are two semi-cylindrical surfaces which will resist the crushing tendency of the 10,286-pound force. It is known that the bearing resistance of each half-cylindrical surface is the same as that of a rectangle having one side equal to the diameter of the bolt and the other side equal to the thickness of the plate. Hence, if t represents the required thickness, and 24,000 pounds the maximum allowable bearing value of the material, the conditions shown in the following equation must exist in order to meet the requirements for safety:

$$2 \times t \times D \times 24{,}000 = 10{,}286$$

or

$$t = \frac{10{,}286}{2 \times 0.75 \times 24{,}000} = 0.285 \text{ inch}$$

Hence, each splice plate must be 5/16 inch thick.

* * *

PRIZE FOR HARDNESS TESTING DEVICE

It has been announced that Sir Robert A. Hadfield has placed in the hands of the Institution of Mechanical Engineers of Great Britain the sum of £200, which, with any income therefrom, may be awarded as a prize for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness. The ordinary tests of hardness fail to some extent when the hardness of the material exceeds about 600 to 800 Brinell. What is desired is the description of a research for or an investigation of some method for accurately determining hardness, suitable for application in metallurgical work in cases in which present methods partially fail. The award will be made by the council of the Institution of Mechanical Engineers, whose decision will be in all cases final. The council will consider annually all communications received, and may then award a prize. But in January, 1922, the offer of prizes will be withdrawn, and any unexpended balance of the prize fund will be diverted to any other purposes to be determined at the discretion of the council. The council may award the whole or any part of the sum available at any time if a communication is received which, in their opinion, is of sufficient orginality and importance and satisfies the object aimed at; or they may from time to time award portions of the fund, not exceeding in all £75 in any one year, for communications which do not completely solve the problem, but which appear to advance the knowledge of methods of testing hardness. The institution will probably be willing and reserve the right to publish in its journal any communications for which a prize is awarded. A communication should be accompanied by scale drawings of any new apparatus described, or by a model or an example of the apparatus itself. If the communication describes a new invention, likely to be of commercial value, it is desirable that provisional protection should have been obtained before it is submitted for consideration. Nothing is said as to whether the competition is confined to British contestants or is international; but information on this point may be had from the Secretary, Institution of Mechanical Engineers, London, England.

Taper, Profile, and Concentricity Gages

By JOHN E. COLLINS

TAPER plug gages are made in various forms designed to meet special conditions. Fig. 1 illustrates three slightly different designs of the ordinary taper plug and ring gage, each being equipped with a standard plug gage handle. Taper plug and ring gages should be made from tool steel, hardened, seasoned, ground and lapped. In setting limits on plug and ring gages, the "Go" line or step, as the case may be, of the plug should coincide exactly with a "Not Go" line on the ring, when the two gages are fitted together. As the plug gage is made first and the ring gage afterward fitted to it, the lines on the ring gage may be transferred directly from those on the plug gage.

The "Not Go" and "Go" diameters on the plug are the same as the maximum and minimum diameters, respectively, that are allowed on the work. The limits on taper limit gages are determined by the longitudinal travel of the gage, which is governed by the maximum and minimum diameters allowed on the part drawings. This method of gaging parts, however, is not the most accurate one, but is the best commercial method devised at the present time.

The type of taper plug and ring gage shown at *B* and *C* is considered very accurate, and differs from the design shown at *A* only in that it has a step ground on the large end of the taper. This step represents the minimum or "Go" diameter on the plugs and the "Not Go" diameter on the rings, as shown in the illustration. The only difficulty experienced in using the step design of taper gages is in attempting to gage work having a very slight taper, in which case the gage is liable to stick in the work and cause difficulty in removing it. This objection may be partly overcome by using a flat plug (shown at *C*), but this gage offers disadvantages in manufacturing, owing to the difficulty experienced in lapping.

Another type of taper gage which is used only on very large work, such as electric generator housings, steam engines, etc., is shown at *D*, Fig. 2. The work end may be provided with a milled step for the minimum depth, the same as a small taper gage, or it may have heavy lines etched on it to indicate the limits allowable on the work. As will be noted from the illustration, bosses are cast on at the ends to furnish a bearing for the lathe centers while the gage is being made. Taper plug and ring gages of this type may be made of cast iron, malleable iron, or steel forgings, as desired.

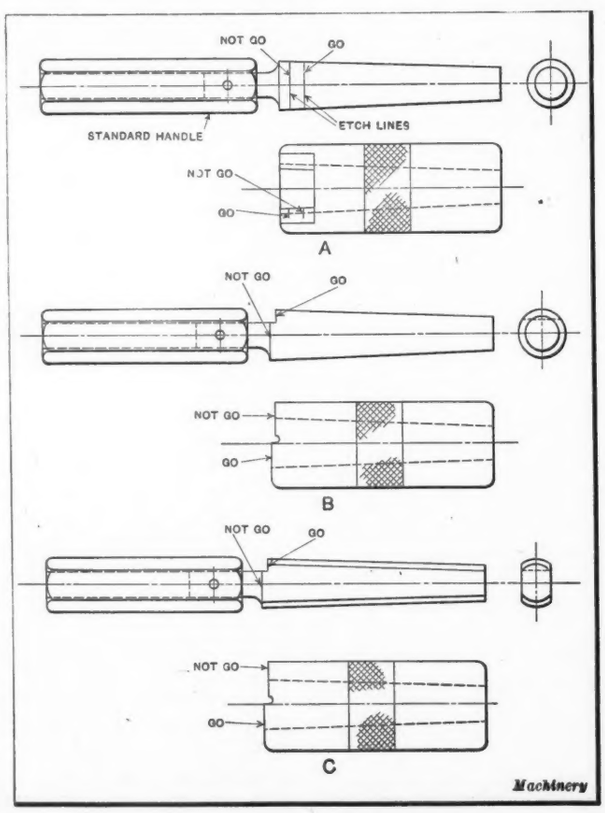


Fig. 1. Taper Plug and Ring Gages

For setting and inspecting tapers, a very good method, and one commonly used, is to employ two straightedges, which are set by means of two accurately ground and lapped disks. This method of laying out and inspecting tapers on plugs is fully illustrated and described in MACHINERY'S HANDBOOK.

All toolmakers' tolerances for taper plug gages should be applied similarly to those for straight plug gages, and also the taper ring gages should have the same tolerance as applied to straight plain rings or female gages. These tolerances are found in Table 4, in the November number of MACHINERY on page 216. Like plain ring and plug gages of the straight type, and in the same manner as previously explained, taper plug and ring gages should be hardened.

Profile Gages

Profile gages which may include gages having contours established either by curved or straight lines, or by both, are used for measuring and inspecting the profile or irregular contours of work. Profiles may be of such form as to require the use of either a male or female gage. It is impossible to standardize this type of gage except in regard to the thickness and grade of steel that should be used.

A few examples are shown in Figs. 4 and 5, reference to which will give an idea of the application of tolerances, and the construction of the solid and built-up designs. No attempt to establish a standard system to be followed in the manufacture of profile gages has been made, but it is suggested that the contour lines of the gage should not deviate more than $\pm$ 0.002 inch at any point from the actual contour of the work, or not more than $\pm$ 0.001 inch from an approved master gage. The use of profile gages should be avoided wherever possible, as this type of gage does not indicate to the inspector the true amount of variation that may exist in the work. The gage must be held in the cor-

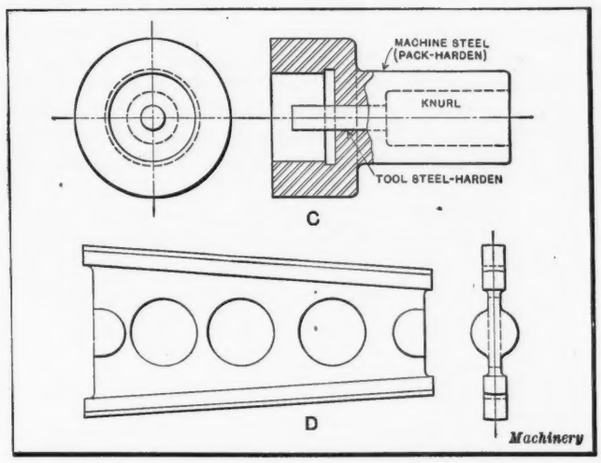


Fig. 2. (C) Combination Male and Female Concentricity Gage. (D) Taper Gage for Large Work

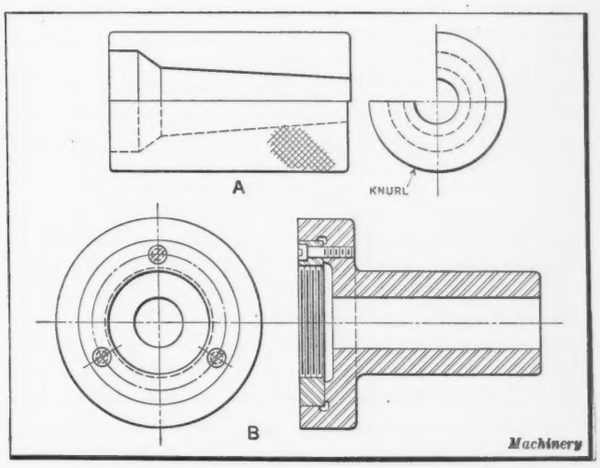


Fig. 3. (A) Profile Gage for Cylindrical Work. (B) Built-up Concentricity Gage for Threaded Diameters

rect position, as shown at *A*, Fig. 5, and the outline inspected by observing if light rays are perceptible between the gage and the outline of the part being gaged. The amount of the deviation from the profile gage outline that is permissible is always more or less arbitrary, and therefore the inspector must rely upon his own judgment when using this type of gage. Profile gages of the flat type should be made from carbon steel containing from 0.30 to 0.50 per cent carbon. The smaller profile gages should be made from ⅛-inch flat stock; those under 6 inches in length should be pack-hardened to a surface content of from 0.90 to 1.00 per cent carbon, then seasoned, ground, and lapped. The larger profiles should be made from 3/16-inch flat stock and hardened on their gaging outline only.

The built-up profile gage is often required to overcome grinding difficulties that are encountered in the solid type of gage. It would be impossible to grind a gage having the dimensions and contour shown at *A*, Fig. 4, if it were made in one solid piece. In the built-up type, the parts are ground to the exact size required and then assembled. The plates are held together by any of the various common methods such as riveting or doweling, or by means of screws, depending upon the size of the gage and general conditions governing its use, but where possible screws and dowels should be used. The method of building up the plates varies in nearly every case, one type being built up flush on one side, and having a back-plate to hold the parts together.

The male profile gage shown at *B*, Fig. 4 is the solid plate type and can be ground and lapped to size without difficulty, in so far as lack of clearance for grinding is concerned. This type is also used as a check for the female gages of both the built-up and solid types. At *B*, Fig. 5, is shown a female profile gage which may be manufactured without being made by the built-up method, since it is possible to relieve the outline of the gage where the different contours or curves join. This relief is indicated by the dotted line which represents the contour of the work. When it is possible to do this, the necessity of making a built-up gage is obviated.

Concentricity Gages

The simplest case in which the use of a concentricity gage is required is where there are two diameters on one shaft which might be correct in size, but not concentric with each other. The concentricity may be determined by making a master gage, which may be considered as being in perfect alignment and as having the correct diameters. For gaging two diameters on one shaft a female gage must be used which should be made to the largest diameters allowed on the work. If the gage passes over both diameters, it is considered correct for all practical purposes. Concentricity gages may take the form of plugs having various diameters, or they may be combinations of male and female gages, as illustrated at *C*, Fig. 2. In gaging the concentricity of tubes, a special type of gage is usually employed, which is known as an indicator gage and which will be described in a later article. The judgment and skill of the designer are of vital importance in producing designs for concentricity gages.

One system for dimensioning concentricity gages is to make all male gages to the minimum diameters allowed on the work and to make the female gages to the maximum work diameters. A gage of this type will always enter the work if it is concentric, provided, of course, that the diameters

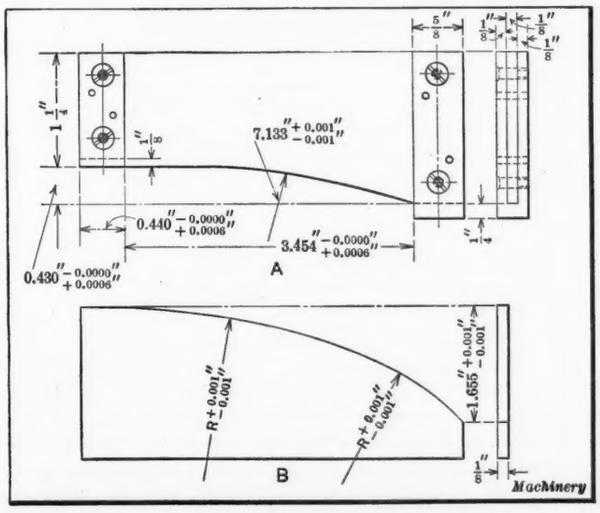


Fig. 4. Built-up and Plate Types of Profile Gages

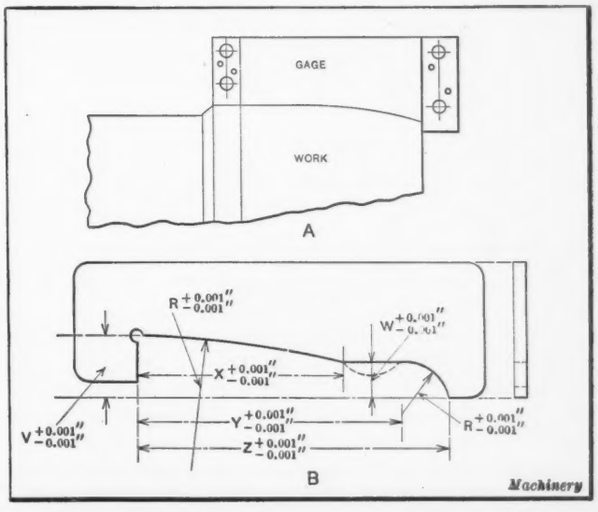


Fig. 5. (A) Application of Profile Gage. (B) Female Profile Gage

themselves have previously been inspected and passed. Another system of dimensioning is based on allowing a percentage for concentricity of the difference between the minimum inside and maximum outside diameters of the work. This system may be best expressed by the following formula:

$$A - X = D$$
$$B + X = d$$

in which

A = minimum inside diameter of work that fits male part of work;
B = maximum outside diameter of work that fits female part of work;
D = diameter of male gage (outside);
d = diameter of female gage (inside);
X = 0.50 per cent of the difference in diameters A and B.

The above formulas are illustrated in the diagram in the lower left-hand corner of Fig. 6. The preferable type of concentricity gage to use depends on the class of work and general shop conditions. Tolerances for concentricity gages are applied in the same manner as those for standard plug and ring gages.

The illustration at E, Fig. 6, outlines a simple type of male concentricity gage for two diameters of different sizes. Standard plug gage handles should be used in every case wherever possible. No detailed explanation of the construction and use of this gage should be necessary. At F is shown a combination male concentricity gage. It would be impossible to make a gage which could be inserted in one end of the work shown at G and which could gage the concentricity of all its diameters at once. By making a gage for each end of the work, and by providing the gage with a sliding plug, the work may be gaged in one operation. In the view at G, the diameters R, S, and T are to be gaged. By referring to the view at F, it will be seen that the gage for diameters S and T contains the sliding plug, which, if the three holes are concentric, will enter a hole in the end of the gage for diameter R, when both gages are in place. The gages are made of hardened tool steel and are provided with standard plug handles.

A type of gage that is used to check or inspect profiles on cylindrical work may be seen at A, Fig. 3. A full lengthwise quarter of the gage is cut away to allow a free inspection of the work. Various shapes may be inspected by the use of gages of this design, and they may also be used to test the concentricity of each part of the work, the profile lines of which do not run at the same angle. One-half of the end

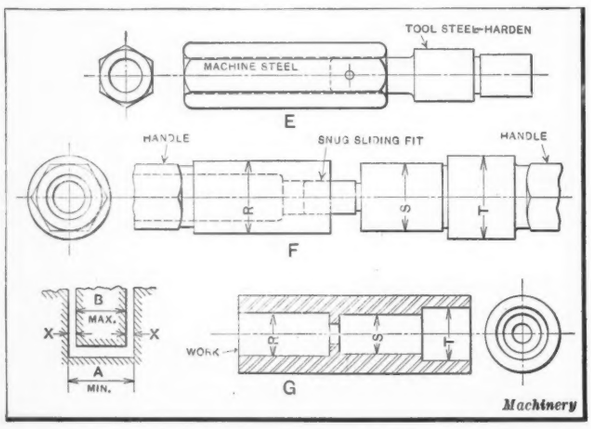


Fig. 6. (E) Plain Male Concentricity Gage. (F) Combination Male Concentricity Gage

area of the gage is milled off shorter than the other half, the amount being determined by the tolerance allowed on the part drawing. This step is shown in the illustration, and gages the maximum and minimum length allowed on the work.

A concentricity gage having internal threads is shown at B, Fig. 3. This type is used to check the concentricity of a part that screws into another part, the part having a close tolerance and being required to be in alignment with the outside diameter or with the shank of the work. As will be seen, the gage is of the built-up type, so as to facilitate machining and to provide for reversing the thread ring when it becomes worn at the end. This design may be made in either the male or the female form. The illustration at C, Fig. 2, is a combination of male and female concentricity gages, and its use is to gage the diameter of a hole and its relation to an outside diameter. This gage may be made in various shapes for both plain and threaded diameters.

* * *

COMPUTATION OF DIAMETERS AND CIRCUMFERENCES OF CIRCLES

By E. T. MEEHAN

The values shown in the accompanying table may be employed to simplify calculations ordinarily required in computing the diameter of a circle from a given circumference or vice versa. It will be seen by inspecting the table that these values consist simply of the value π, multiplied by each unit from 1 to 9 inclusive, and also the reciprocal of π, similarly multiplied by these units.

VALUES FOR COMPUTING DIAMETERS AND CIRCUMFERENCES OF CIRCLES

(VALUES OF π)

Integer	Multiple	Reciprocal	Integer	Multiple	Reciprocal
1	3.1415926536	0.31831	6	18.8495559216	1.90986
2	6.2831853072	0.63662	7	21.9911485752	2.22817
3	9.4247779608	0.95493	8	25.1327412288	2.54648
4	12.5663706144	1.27324	9	28.2743338824	2.86479
5	15.7079632680	1.59155	..	.....	*Machinery*

It is the belief that the use of these tables will result in a great saving of time for draftsmen and others engaged in work requiring the use of such mathematical computation. As is well known, the circumference is generally found by multiplying the diameter by the value 3.1416, or π, and reversing this operation when the circumference is known and the diameter is required. By using the values in the table and following the method to be explained, slightly more accurate results can be obtained, a considerable amount of time can be saved, and the possibilities for errors will be greatly reduced. It will be noticed that the multiples of π are carried out ten places, but of course in common use there is no need of using more than four or five of these. The reciprocals are carried out only to five places and, as shown by the following examples, will give ample accuracy.

Examples—The diameter of a circle is 37.541 inches; find its circumference. From the multiple values in the table:

$$30 \times \pi = 94.24778$$
$$7 \times \pi = 21.99115$$
$$0.5 \times \pi = 1.57080$$
$$0.04 \times \pi = 0.12566$$
$$0.001 \times \pi = 0.00314$$

117.93853 inches

Find the diameter of a circle whose circumference is 37.541 inches. According to the reciprocal values:

$$30 \div \pi = 9.5493$$
$$7 \div \pi = 2.2282$$
$$0.5 \div \pi = 0.1591$$
$$0.04 \div \pi = 0.0127$$
$$0.001 \div \pi = 0.0003$$

11.9496 inches

* * *

The United States Senate has passed the Kenyon Americanization Bill which requires all residents of the United States between the ages of sixteen and twenty-one, not mentally disqualified, and all alien residents of the United States between the ages of sixteen and forty-five, who cannot speak, read or write English, to attend school not less than 200 hours a year.

Rescission of Sales Contracts

By CHESLA C. SHERLOCK

IT is just as necessary for men engaged in business to know what constitutes a valid termination of a contract as it is to be familiar with the requirements for the writing of a contract that will be legal. There are times when a sales contract must be rescinded, and the question is, what legal requirements must be preserved in order to permit the sales contract to be rescinded by one of the parties, or by an agreement between both? When can the seller rescind, when can the buyer rescind, and what is necessary to terminate an agreement between two parties by voluntary action on the part of both?

It is generally stated as a broad rule of law that the same elements that are necessary to constitute a valid contract in the first instance are necessary to rescind the same contract—that is, there must be some kind of agreement between the parties, either expressed or implied; there must be a consideration; and the object must be lawful and the agreement must be adequately expressed. When the parties to the contract mutually agree to dissolve the agreement, there is not much that can be said; but the parties do not agree on a matter of this kind in about nine out of ten of the cases. One party is generally going to profit by the contract and he wants to hold the other party to it.

The United States Supreme Court decided a case which throws some light upon the subject. In that case the buyer purchased a stated number of tons of old iron rails. Later the board of directors of the railroad company ratified the contract and notice was sent to the buyer stating that the "tons" were short tons. The agreement had been for long tons, but that was not expressly mentioned in the contract. The buyer immediately notified the company that the agreement had been for long tons and that he would expect delivery and requested a reply. He did not, however, receive a reply, and therefore acted upon the assumption that the company had rescinded the agreement. Upon the matter coming before the court, it was held that this conduct on the part of the company did not amount to a rescission of the contract and that the company could hold the buyer to the agreement.

General Principles Governing Rescission of Contracts

It is a general rule that contracts may be rescinded by mutual assent between the parties. This rescission may be made orally, even though the former agreement was in writing. There is nothing in the law that requires a rescission, in order to be valid, to be in the same form as the original agreement. Formerly, at common law, it was held that all contracts under seal could not be rescinded except by a specific agreement also under seal. The tendency has been, however, to remove this restriction even as to contracts under seal, so that it may now be stated as a general rule that oral agreements to rescind are valid and enforceable.

Rescission need not necessarily be express; it may be inferred from the conduct of the parties, provided that it is such as to evidence clearly their intention to treat the contract as at an end. If the seller under a sales contract refuses to make delivery according to its terms, such refusal may be treated as ground for rescission by the buyer. The buyer is under no obligation to take delivery under a sales contract unless it is made in conformance with the terms of the contract.

Where the contract calls for the delivery of the goods at a specified time, the buyer is under no obligation to accept delivery at some other time, and may treat the failure to make delivery as a basis for rescission. The same rule holds true where the contract calls for delivery of a certain amount at a specified time, and the seller tenders only a part of this amount. On the other hand, the refusal of the buyer to take delivery may be treated as ground for rescission by the seller; default in payment of price on proper tender of delivery will also ordinarily justify the seller in rescinding the contract.

Sales and Contracts Involving Credit

A great deal of the importance of this subject of the law arises in the case of sales on credit or on the installment plan. The vast majority of the cases are lodged under these two classes, as the difficulties occurring do not seem to be so numerous where the sale is for cash upon delivery. It is held by the courts, where a contract has been entered into between the buyer and the seller, on credit, that it is an implied condition that the buyer will keep his credit good; and in case he becomes insolvent, the seller has a right of rescission, or may decline delivery, except upon payment of cash, regardless of the terms of the contract.

It is also a general rule that even though the sale is executed so as to pass title, mutual rescission and the return of the property to the seller releases the buyer from any liability for the payment of the purchase price. In Connecticut and Virginia, particularly, it has been held that where there is a mutual rescission of a contract of sale, under which part payments have been made, the buyer is entitled to the return of the payments made in the absence of express or implied agreements to the contrary.

Sales on Credit and Partial Payment Basis

The great majority of sales contracts executed at the present time are on a credit basis; and many sales are on an installment basis. Since this basis enters so largely into everyday business relations, it is surprising that the legal aspects of the relation are so little understood. Sellers contract to sell machinery upon installment payments; later, when they agree to rescind the contract and take back the machinery, they expect to keep all the payments which the buyer has made. Goods are sold every day on the installment basis, the seller thinking that in case of default or rescission of the contract that he will have the right to both the payments made and the property.

It is a broad rule that failure to make delivery upon one installment or payment, as the case may be, is not sufficient to permit the other party to rescind the contract, unless such default was accompanied with conduct sufficient to evidence an intention to abandon the contract.

There seems also to be, however, a common interpretation to the effect that default of either party with respect to one installment, provided such default has not been waived, justifies the other party in putting an end to the contract. The courts of Indiana, Maryland, New York, and Tennessee have so held, in cases now considered as leading cases on this point. The general effect is that rescission will be justified on the part of the seller where the buyer fails to pay for an installment, or he may refuse further performance of the contract, but it does not, if the buyer has not otherwise repudiated the contract, authorize the seller to treat such non-payment as a breach of the contract that will entitle him to recover anticipated profits on the unperformed part of the contract without a tender of further installments in accordance with the terms of the contract.

Contracts Invalidated by Non-Compliance

So far we have been dealing largely with instances where the ground for rescission is found in the implied acts of the other party. Where the conduct of the other party is express and there is no need to resort to inferences, some little difference naturally arises as to the rights and obligations of the parties under the law. There is a great difference between default of a contract or non-performance, and rescission. Rescission implies something of a mutual consent or assent. Many of the rights permitted to the parties on failure to meet installments in sales contracts are permitted as penalties because of non-performance, and not because there has been ground for rescission. As one authority pointed out, if there has been a rescission of the agreement, then the liabilities contained in the contract cease with the contract. If there has been no rescission, but the seller or the buyer, as the case might be, has performed his share of the agreement, he can enforce the contract against the other party and hold him to the terms of the agreement or receive damages for non-performance. But rescission does not permit any of this on the part of the seller. If the seller, for instance, upon default of the buyer, rescinds the contract, then the seller loses all right to proceed under its terms against the buyer. If the seller rescinds the contract upon the default of a payment by the buyer and the buyer returns the machinery or the goods to the seller, then the seller must return the installments already paid to the buyer.

The same is true where the seller has failed to make his deliveries in the time and manner specified in the contract. If the seller fails to deliver his installment in the manner and in the amount specified in the contract, the buyer can rescind the contract. If he returns the goods already delivered, he has a right to receive back such installments as he has paid. If he retains the goods already received, the seller has a right to retain the installments that have already been paid.

There is a mutuality to the rescission of sales contracts which is everywhere present. It is a subject, which like that of the formation of contracts in general, must rest upon the meeting of the minds, express or implied, of the parties. The form of such assent is not so material as that it should be clearly evidenced.

* * *

THE EUROPEAN INDUSTRIAL SITUATION

An Abstract of a Resume of the General Findings of the Trade and Finance Committee of the Council on Foreign Relations

England, France and Italy are making encouraging progress in reconstruction. As a rule the manufacturers are working to capacity and find a ready sale at high prices for their products. The principal difficulties are: First, reduced production due to the general attitude of labor; second, the inability to enlarge plants or to run to capacity already existing plants, due to shortage of labor; and third, the excess of imports over exports, producing an unfavorable exchange situation in dealing with the United States. It is generally agreed that there are two remedies for the exchange problem: First, a temporary remedy, which can be brought about by loans, investments, and credits by citizens of the United States to those of other countries; and second, a permanent remedy which can only be accomplished by those other countries exporting more goods than they import. This balance of exports is necessary to pay the interest and principal of the war debts to America.

British and other European manufacturers are of two minds regarding the exchange situation at present; as citizens they regret to see the currency of their country depreciated as compared with that of any other country, but as manufacturers they recognize that this gives them a considerable premium on the sale of merchandise to the United States. British, French and German goods of various kinds are now beginning to come into the United States, and there would already be a great flood of foreign merchandise here but for the fact that the purchases in their own home markets are larger than ever before. The people in England and France are living extravagantly, just as they are here, and it seems impossible to turn out merchandise that will be too expensive to find a market.

In some countries there is a well organized effort being made to create increased output on the part of the manufacturer and the individual worker, and reduce home consumption by showing that the exchange question and hence the cost of living can only be remedied by consuming less, and selling more abroad; and among manufacturers and business men abroad there are many who feel that stimulation of production and rigid economy to bring down costs are the *only* things that will correct exchange. There is a great development along the lines of association work in the different trades to bring about this result.

The greatest difficulty which foreign manufacturers are now facing outside of their high cost of production is the fact that their bankers, who before the war cooperated with them in financing foreign trade, now find the foreign countries going to the United States for money. This emphasizes one great opportunity which the United States now has; wherever we can make loans or give sufficient credits to enable the foreign purchasers to trade with us we have an opportunity to trade. This is only possible, however, if the American manufacturers and bankers can learn to work together as closely as did those in Great Britain and those in Germany before the war.

We have been accustomed to feel that our home market was the sole consideration of our manufacturers; hence the manufacturer in this country has always favored a high protective tariff. During the war many of our industries have increased their capacities to where they can more than supply the normal home trade and they are looking abroad for markets. The high premium on our dollar more than offsets the tariff; hence the foreign manufacturers can send goods here more advantageously than they can sell them at home, while the same premium on the dollar practically prohibits our manufacturers from selling abroad when there is any sort of competition from countries whose exchange is lower. The fluctuations in exchange also introduce a speculative factor which compels us to put on a larger percentage of profit to offset any change in exchange which may occur between the booking of an order and its delivery.

In discussing these subjects both abroad and at home one is struck with the fact that able men are individually or in small groups working on these problems, but they seem to have found no way to coordinate their efforts. Even among our New York bankers there are decidedly different opinions as to the best course to pursue. It is useless for us to look for a panacea for all our ills, but all authorities agree that no country can be independent commercially or financially from the rest of the world, that the present problems must be approached broadly as world problems, and that the United States has now its great opportunity for leadership if it has the vision and will take the responsibility.

* * *

NORTON CO. TO BUILD HOMES FOR EMPLOYES

The Norton Co., Worcester, Mass., is planning to erect homes for 100 families in the Norton Village, the second community to be established at Indian Hill, Worcester, for men working at the Norton plants. A tract of over fifteen acres has been laid out on the northern slope of Indian Hill and the Frank T. Ley Co. of Springfield, Mass., has undertaken the contract to erect 100 houses to be completed in the early part of June. It is planned to create a village to have its own park, community buildings, boarding houses, stores, and five-room homes. The intention is to rent these homes to employes of the Norton Co., but an opportunity will be provided for the occupants to purchase them, should they so desire.

LETTERS ON PRACTICAL SUBJECTS

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FLAT SPRING BENDER

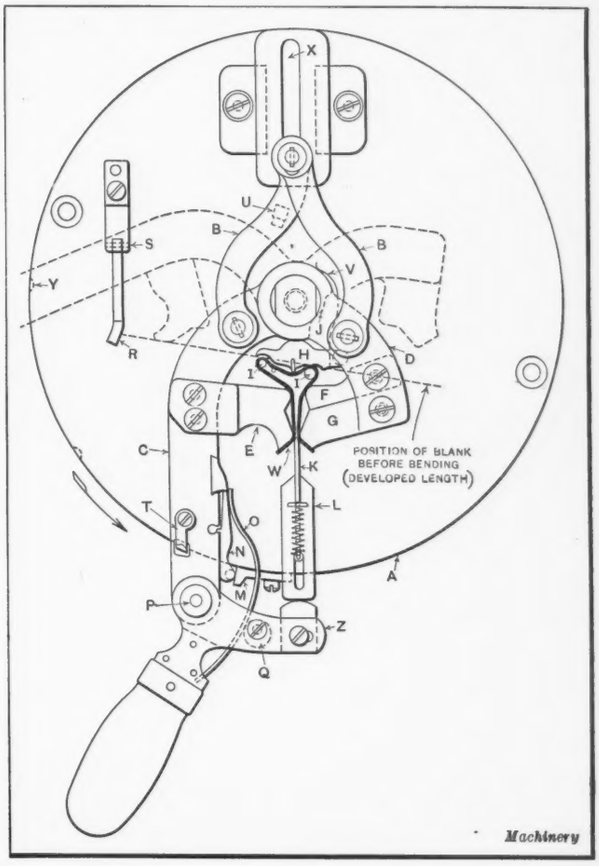
The flat spring bender illustrated embodies some interesting mechanical movements. In the design of the fixture, the movements were worked out by means of a cardboard templet—a method which will save considerable time in laying out the functional parts of mechanisms of this general type. The work for which this fixture was designed is made of flat spring brass, 0.025 inch thick and 3/16 inch wide, and contains eight bends, as shown in the illustration, *W* representing the shape of the spring after being formed.

The fixture consists of a cast-iron base *A* which is machined all over and on which the various parts are mounted. To load the fixture, the operating lever *C* is swung clockwise to the position shown by the dotted lines. In this position, the operating lever arm *D* is raised so as to permit the insertion of the blank in the position shown in the illustration. It will be apparent that lever *C* and arm *D* operate in unison and that they are connected by means of two toggle levers *B* which are hinged together so as to travel radially in the slot *X*. With the operating lever in the back position under joint *S*, the stop *R* is held in place while the fixture is being loaded, and the cam section *J* of the operating lever is swung around permitting cam-lever *H* to be sufficiently raised by the action of the flat spring *V*, to permit the work to be readily placed in position. The radial position of the operating lever is determined by the index spring *T* engaging the spot *Y* on the periphery of the base. The operating lever is next swung in the direction of the arrow, raising the stop and causing the toe of the cam *J* to force the cam-lever *H* against the work, thus securing it against the two pins *I*. In the meantime, the two forming members—*E* on the left-hand side and the two-piece former consisting of parts *F* and *G* on the right-hand side—will bend the ends of the stock until they are closed as shown. It will be noted that the cam-lever *H* has a blade which prevents the stock from "creeping" after it starts to bend.

Attention is directed to the fact that the forming members are not similarly constructed. The explanation for this is that the bend formed by the heel on the left-hand side, is considerably further removed from the left-hand pin *I* than is the corresponding bend on the right-hand side. Provision for adjusting the location of this bend is made by constructing the right-hand former in two parts, so that *F* may be set to suit. The ductility of the stock from which the springs are made may influence the relative location of the bends sufficiently to require adjustment of this former. The lower ends of the spring are prevented from closing by a flat separator bar *K* against which the stock is forced by the formers, causing the ends to spread slightly. Directly following this operation, the lever *N* comes into contact with the lever stop *M*, causing the end of the lever to swivel outward and force the joint spring *O* out of contact with its stop, thus permitting the joint *P* to be broken. Adjustment of tension for spring *O* is accomplished by means of the eccentric cam *Q*.

It will be seen that continued pressure on the handle of lever *C* will operate the extension arm and advance the end former *L*, against the force of a coil spring, upward against the partially spread ends of the work, and thus complete the forming of the spring. A certain amount of lateral deflection is provided for bar *K*, which is necessary in order to allow it to align itself with the work, thereby compensating for the slight amount of lost motion produced by the toggle jointed levers. The spring is removed from its position on the fixture by swinging the lever *C* clockwise until it comes in contact with the trigger *U*, which is located in the base and which operates a device on the under side of the base, by means of which the two pins *I* are depressed. At the same time, the action of the flat spring *V* lifts the cam-lever *H* upward so that with both pins *I* depressed and the cam *H* raised, the finished spring simply lies on the top of the base.

When in use, the fixture should be placed on an inclined plane, so that when the spring is released, as just explained, it will slide off the fixture, enabling the operator to swing the lever again into the position shown in the illustration,



Bending Device for forming Flat Springs with Eight Bends

load another piece of work, and continue the cycle of operations as before. All the functional parts of the device are made of tool steel and are hardened, while the inoperative parts, except the base, are made of cold-rolled steel, case-hardened.

Worcester, Mass. L. W. RICHARDSON

KEEPING RECORDS OF AUTOMATIC SCREW MACHINES

It is often desirable to keep a permanent record of each cam designed for producing various types of work on automatic screw machines. These records should consist of the calculations required in proportioning the cam, the method of laying out, and the method of setting up the milling machine when cutting. A set of data sheets such as was used to keep records of the cams required to produce the pivot screw shown in Fig. 1, on a Brown & Sharpe automatic screw machine, will facilitate the keep-

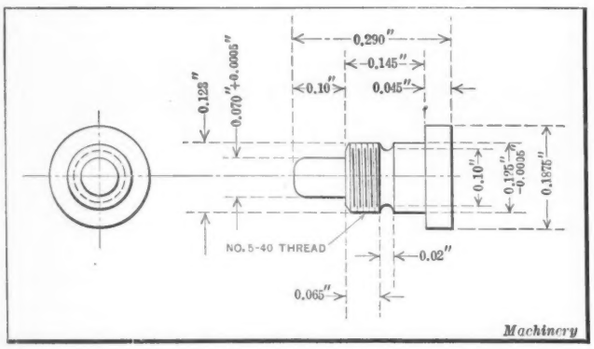


Fig. 1. Sample of Work produced on an Automatic Screw Machine

ing of such records. These data sheets are illustrated in Figs. 2, 3, 4, 5, and 6, and quantities of blank forms should be kept on hand to be filled out.

Before designing a cam, it is necessary to determine the spindle speed most suitable for the kind of material and size of stock that the work is to be made from; the number of revolutions of the spindle required to perform each

Gears	Driving	40	Time For One Piece 12 Seconds
	1st		
	2nd		
	Driven	48	

OPERATIONS	Spindle Rev. for Oper. Based on 927 R.P.M.	Spindle Rev. for Each Oper. Based on 1748 R.P.M.	Hundredths of Cam Circumference
Form—Front tool 0.079" + 0.005"			
Feed P. R. 0.0005" & 0.0003"		178	51
Tool clearance			4¼
Thread on No. 5-40 Std. die	7	13	3¾
Thread off		7	2
Tool clearance			2
Index turret			
Cut off—Back tool 0.094" + 0.025"			
Feed P. R. 0.0016", 0.0005 & 0.002"		107	30
Tool clearance			1
Feed stock to stop		16	5
Tool clearance			1
Index turret			
Total number of hundredths			100
Total number of revolutions		321	
Number of revolutions figured on		350	

CALCULATION DATA SHEET
Part No. 231 Name:—PIVOT SCREW
No. 00 B. & S. Auto. Screw Machine
Machinery

Fig. 2. Record of Calculations Necessary for designing the Cams

operation; and the number of revolutions of the spindle during the feeding of the stock and the indexing of the turret. Sufficient time must also be allowed to enable the tools to clear each other. From these data the lay-out of the cam can be made. The circumference of the cam blank is first divided into 100 equal parts. Each of these divisions represents a certain number of revolutions of the spindle, which is determined by dividing the total number of revolutions of the spindle required to produce one piece of work, by 100. The contour of the cam is then laid out on the blank, these divisions being used to obtain a curvature which will impart the required motion to the tools.

The data sheet used to record the calculations involved in designing the cams for the pivot screw is shown in Fig. 2. This sheet provides space for a list of the operations performed on the screw; the number of spindle revolutions required for certain operations based on the slow speed of the spindle; the number of spindle revolutions required for each operation based on the fast speed of the spindle; and the number of hundredth divisions of cam circumference required for each operation. It will be noted that the screw was threaded while the spindle was revolv-

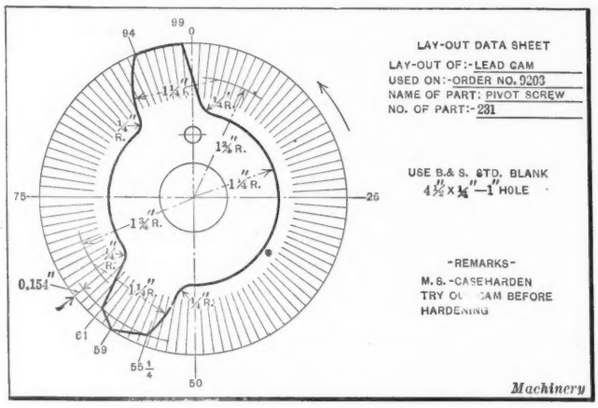


Fig. 3. Lay-out Data Sheet of Lead Cam for producing Screw shown in Fig. 1

ing seven revolutions at a rate of 927 revolutions per minute, and that all of the other operations were performed with the spindle revolving 1748 revolutions per minute. As the cam design was based upon a rate of 1748 spindle revolutions per minute, the time consumed in threading the screw would be equivalent to about 13 revolutions at that rate of speed. Information relating to the cutting operations, such as the depth of cut and the rate of feed, was placed on the data sheet with the various operations. Thus, "0.079 inch + 0.005 inch" means that the forming tool was fed 0.079 inch into the stock and that 0.005 inch was allowed for clearance; and "Feed P R 0.0005 inch and 0.0003 inch" means that at the beginning of this operation the feed was 0.0005 inch per revolution and reduced to 0.0003 inch per revolution in order to produce a smooth finish. Memoranda of the change-gears used and the time required to produce one piece of work are also included in this record sheet.

The time consumed in indexing the turret would frequently enter into the design of the cam, and proper portions of the cam circle should be allowed for this purpose. In this particular case, however, the turret was indexed during the forming and cutting-off operations so that this factor did not enter into the design of the cam. It will be noted that 350 revolutions of the spindle were allowed for the production of one piece so that one division on the cam circumference represented 3.5 spindle revolutions.

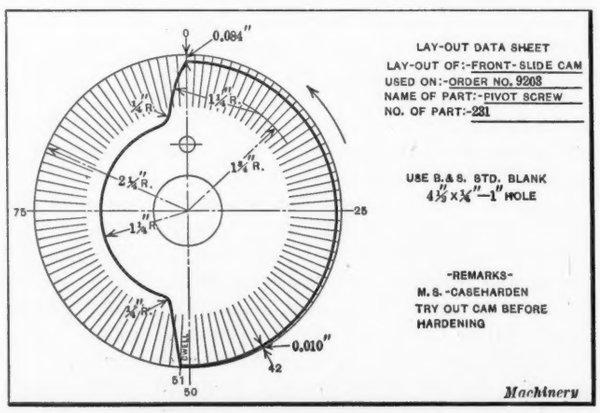


Fig. 4. Data Sheet Record of the Front-slide Cam

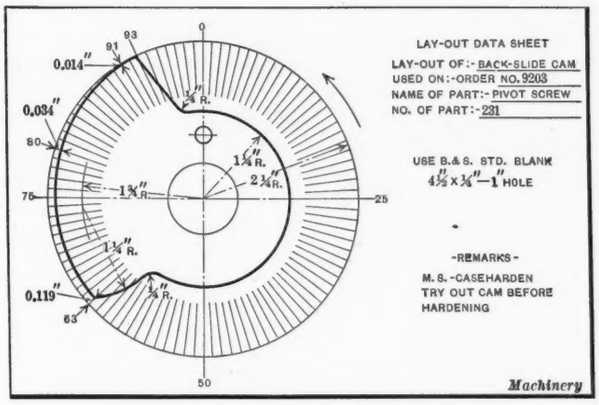


Fig. 5. Data Sheet Record of the Back-slide Cam

The lead cam lay-out illustrated in Fig. 3, as well as the front- and back-slide cam lay-outs, Figs. 4 and 5, were developed according to the calculations tabulated in Fig. 2. The divisions of the circumference of the cam circles corresponding to the various operations performed in making one screw are as follows: From 0 to 51, forming; 51 to 55¼, tool clearance; 55¼ to 61, running the threading die on and off; 61 to 63, tool clearance; 63 to 93 cutting off; 93 to 94, tool clearance; 94 to 99, feeding stock to stop; and 99 to 100, tool clearance. A record of the method of setting up the milling machine dividing head to provide for milling the lead, front-, and back-slide cams was kept on a data sheet of the type shown in the illustration Fig. 6. Tables for computing the gears to be used and the angular setting of the dividing head for this purpose, can be found in various handbooks.

Hartford, Conn. SVEND HELWEG

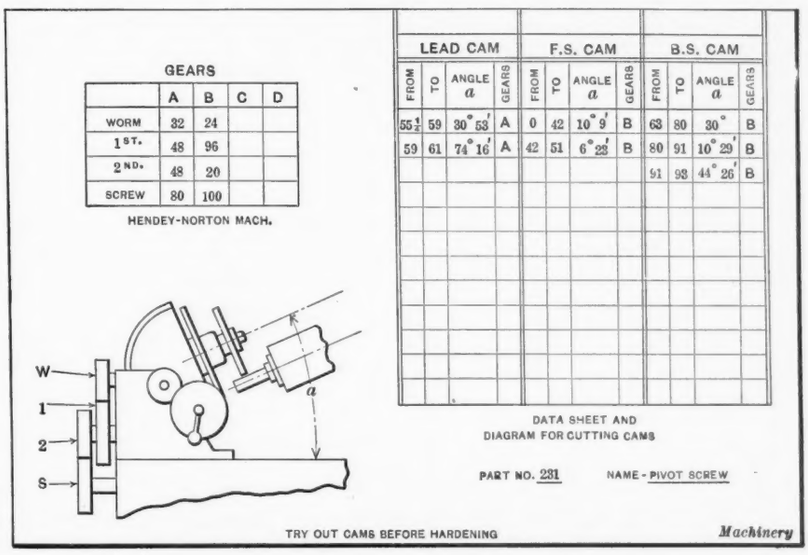


Fig. 6. Set-up of the Milling Machine for milling the Cams

PRESSURE FACTORS FOR FORCE FITS

It is often required in the routine of machine shop work to know how much pressure is required to force a steel shaft into a machined hole of a specified length and sufficiently under size to produce a good forced fit. The pressure in tons that will be required to force the shaft into the hole, may be easily determined by multiplying together the circumference of the shaft, the length to which the shaft is to be forced in, the amount in thousandths of an inch that the shaft is larger than the hole, and a constant selected from the accompanying table.

Diameter (Inches)	Pressure Factor	Diameter (Inches)	Pressure Factor	Diameter (Inches)	Pressure Factor
1	250	2¾	85	5	45
1¼	200	3	80	5½	40
1½	160	3¼	70	6	37
1¾	140	3½	65	6½	34
2	120	3¾	60	7	32
2¼	105	4	55	7½	30
2½	95	4½	50	...	..

Machinery

The rule given may be conveniently written as a formula:

$$3.1416\ DLBF$$

in which D = diameter of shaft;
L = length of fit;
B = forced fit allowance in inches;
F = pressure factor.

Example—What pressure will be required to force a steel shaft 2¼ inches in diameter into a hole which is 0.006 inch smaller than the diameter of the shaft, if the length of fit is 3 inches?

Substituting the values given in the above formula we have:

$2\frac{1}{4} \times 3.1416 \times 3 \times 0.006 \times 105 = 13$ tons, approximately

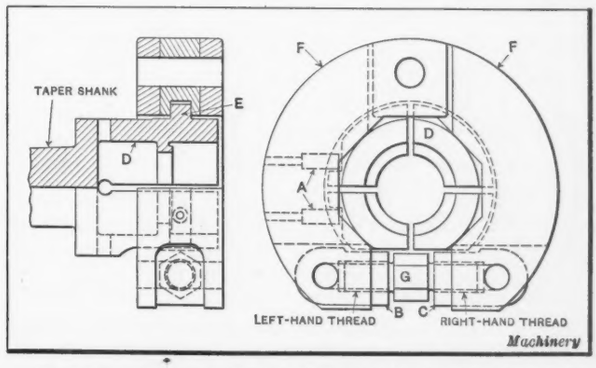
In performing forced fit operations on an arbor press, it is recommended that a lubricant consisting of white lead and lard oil mixed to the consistency of thick paint be used.

Bridgeport, Conn. R. S. MYERS

CHUCK-TYPE DRIVER FOR CAMSHAFT

The accompanying illustration shows a chuck type of driver of unusual construction, which was designed for use in facing the cams and flanges on a one-piece automobile camshaft—a machining operation for which an ordinary lathe dog provided insufficient driving power. The device consists of an arbor D and means for clamping the work in the arbor proper, which is constructed on the same principle as the common spring collet, but the means of clamping is more powerful and less complicated than that ordinarily used in connection with spring collets. The clamping arrangement consists of two C-shaped clamps F hinged at one side of the arbor and connected at the other by two links B and C, and screw G by means of which the clamps are tightened. The opening formed by the C-clamps is octagonal in shape, four sides of this opening being in contact with the arbor, while the other four sides have 1/16 inch clearance. Lateral movements of these parts is prevented by a flange E turned on the arbor, which fits into a groove in the C-clamps, while pins A prevent the clamps from rotating on the arbor.

A desirable feature of this arbor is that it has no projecting screws or pins, thereby lessening the chance of injury to the operator. In machining the camshaft on which this chuck



Chuck Type of Driver employed to hold and drive One-piece Camshaft while performing Multiple Facing Operations

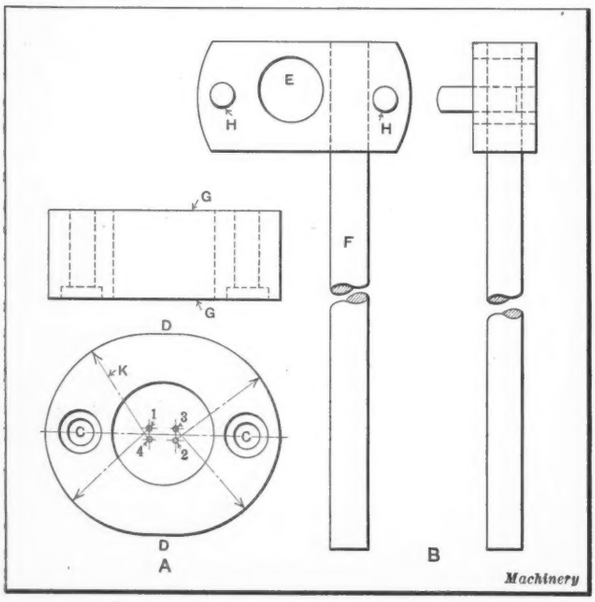
was employed, it was first necessary to center the rough shaft at both ends. The end having the larger diameter was next turned to size, being held within close limits so that the special driver described could be employed on all the succeeding lathe operations. As the driver was employed when facing both sides of four cams and the faces of two flanges at one time, it is evident that the device is a very powerful and efficient driving medium and can be employed for taking heavy cuts with little possibility of the work slipping away from its driver.

Buffalo, N. Y. LEROY JAGOW

HOLDING DEVICE FOR GRINDING CAM PERIPHERY

The accompanying illustration shows a cam *A*, and the holding fixture *B* which was designed and successfully used for grinding the periphery of the cam. The work was made of machine steel and was ground after hardening. After being laid out, the piece was roughed down to grinding size; the holes *C* accurately spaced and carefully drilled and reamed; and the large hole in the center rough-machined, leaving sufficient grinding allowance. The cam was then hardened and the large hole, the two sides *G*, and the two flat parallel spots *D*, ground to size.

The cam was then ready to be ground on its periphery, for which operation the fixture *B* was especially designed. When grinding, the cam is held on two dowel-pins *H* located in the fixture so as to correspond with the location of the holes *C* in the work. The hole *E* is located in the fixture so that its center bears the same relation to the center of the dowel-pins that the holes *C* bear to one of the four centers from which the cam radii are located. The cam is secured to the fixture by means of a special stud, the diameter of which fits in hole *E* and permits the fixture to be swung about the stud center. The central hole in the cam is large enough to allow the stud to pass through it so that the work may be readily clamped in position by the use of a nut and washer. Then, by locating the piece in the fixture so that center 4



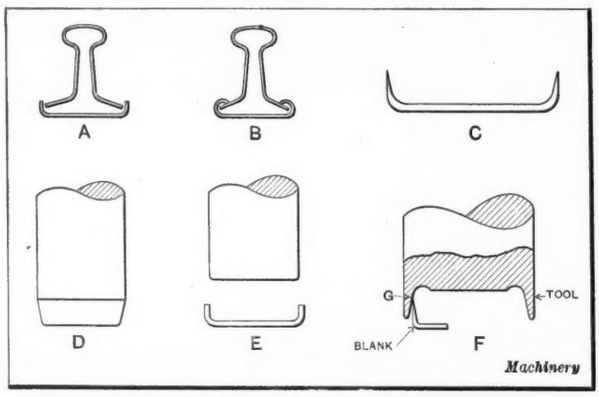
Cam and Special Holding Fixture employed in grinding Periphery

coincides with hole *E*, the periphery of the cam determined by radius *K* may be ground. By relocating the cams in the fixture so that centers 1, 2, and 3 will, in turn, coincide with hole *E*, the remainder of the periphery may be accurately ground. The stud, or mandrel, contains centers by means of which it is supported between the centers of the grinding machine, the rod *F* being used as a handle for oscillating the cam through an arc of approximately 45 degrees while being ground. This handle is also employed as a stop to locate the end of the stroke, it being allowed to drop down so as to rest against a parallel clamped to an angle-plate which is secured to the table of the machine. By properly adjusting the parallel, the four arcs may be ground to the desired radius so they will be tangent with flat sides *D*.

Beverly, Mass. JOHN T. CLARK

PUNCH AND ROLLING TOOL FOR SMALL METAL PARTS

Rolling operations are often performed on small sheet-metal articles such as collar buttons for the purpose of locking the parts together. Such operations usually consist of rolling the edge of the stock as shown in the illustration at *B*. Preparatory to performing this operation, the stock should be beveled off at the edge as shown at *C*. This bevel or taper is produced during the pressing operation by a punch



Work requiring Rolling Operation, Shape of Plate to be rolled and Tools employed

of the type shown at *D;* thus instead of using a straight punch and folding the metal to the shape shown at *E*, it is squeezed against the side of the die. When the metal is simply folded over as at *E*, the edges, when rolled, are likely to be uneven, while if tapered as at *C*, the top edge is nearly smooth and uniform, and the operation can be performed in a very satisfactory manner with little difficulty. The tool employed is shown at *F* and is designed so that its rolling surface will contact with the tapered part of the blank at *G*, causing the metal to curl in the circular recess within the rolling tool and produce a smooth even roll as the tool descends. The curved part of the tool must be absolutely smooth, and should be first polished with a wooden stick, using an abrasive material such as very fine diamond dust, after which it should be polished in a speed lathe with crocus.

Philadelphia, Pa. S. B. ROYAL

AUTOMATIC FEED FOR DIE AND PIVOTED STOP FOR STOCK

The feed mechanism illustrated in Fig. 2, is an inexpensive arrangement and may be satisfactorily employed in connection with blanking dies. As shown, a reel is placed on each side of the power press and in line with the stock slot in the die. The reel at the right side of the machine holds the stock and turns on a dead axle, while the one at the left is for scrap and is turned by a flanged pulley driven by a very loose belt. While the punch is in the stock, the slippage of the loose belt will allow the feed to stop, but as soon as the punch is cleared, the left-hand reel will again revolve and pull the scrap stock forward against an automatic stop. The cores of the reels are split at an angle, so that by loosening the wing-nut *W*, the front flange with half the core attached may be removed. This leaves the scrap coil on the back half of the reel core, so that it can be easily bundled and removed.

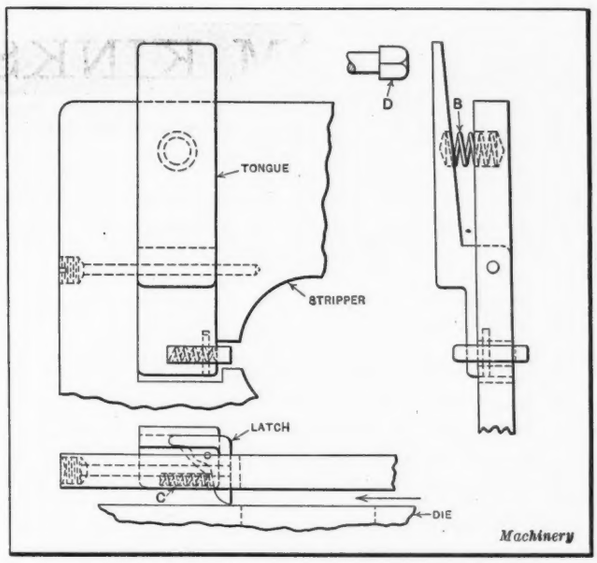


Fig. 1. Latch Stop used in Connection with Automatic Feeding Arrangement

The position of the automatic stop previously referred to is shown at *A*, Fig. 2, and the details of its construction are shown in Fig. 1. The stop consists of a pivoted tongue carrying at one end a latch which is hinged in a slot as shown. The point of the latch has a movement of about 1/16 inch and when free is kept forward by spring *C*. The function of spring *B* is to keep the latch against the top of the die, where it acts as a stop after the punch has been withdrawn from the work. As the stock is fed into the die, it is stopped by the point of the latch, which it forces back about 1/16 inch or as far as the depth of the slot will permit. This locates the work in the proper position, and as the punch descends and enters the stock, the latch is raised by means of the set-screw *D* which depresses the tail of the tongue. The latch is snapped forward by spring *C* as soon as it has been raised sufficiently to permit this action.

After the punch has completed its work and has begun its ascent, the point of the latch is in the advanced position so that when spring *B* forces the latch down it will come in contact with the top of the scrap between the blanked holes. The stock then feeds forward and as soon as the bridge between the two holes has passed the point of the latch, the action of spring *B* forces the latch into contact with the die. The latch is now in its original position, from which it is again forced back into the slot to the correct location by the advancing stock. This stop is an excellent one for use on hand-fed dies, as the operator is only required to start the stock and then with the press-treadle held down, pull the scrap through until the entire strip is blanked.

Montclair, N. J. ROY V. TERRY

A COMBINATION LOCATING BUTTON AND PRICK-PUNCH

A combination locating button and prick-punch shown in the upper right-hand corner of the accompanying illustration has proved a satisfactory tool for locating holes in dies and similar flat work in which the holes must be in an exact relation to each other. As shown, the tool consists of the button *A* having a concentric hole in which a prick-punch *B* is carefully fitted. The point of the prick-punch is, of course, located in the center of the button, so that it is concentric with the outside circumference.

In the lower view is shown the method of employing the tool when locating three holes in a plate. The flat square *C* is first clamped to the work. Then by putting size blocks of the correct thicknesses between the edge of the square and the circumference of the button as shown at *D* and *E*, and lightly tapping the prick-punch, marks are produced which if trued up accurately and bored will prove to be very accurately located in their required relation to each other. When locating the hole at *E*, a stack of size blocks must, of course, be used in the same manner as shown at *D*, to obtain the setting indicated by dimension *H*. To obtain accurate results, it is obvious that all holes must be laid out at one setting of the square. The saving in time over the button method usually employed is considerable, as no time is wasted in drilling and tapping for the button screws, and the tedious job of locating is also eliminated. An accurate flat square and a set of size blocks are required, however, but for quickly and accurately locating holes in work such as described, this method is as satisfactory as any that the writer has employed or heard of.

Newark, N. J. JOHN A. SHAND

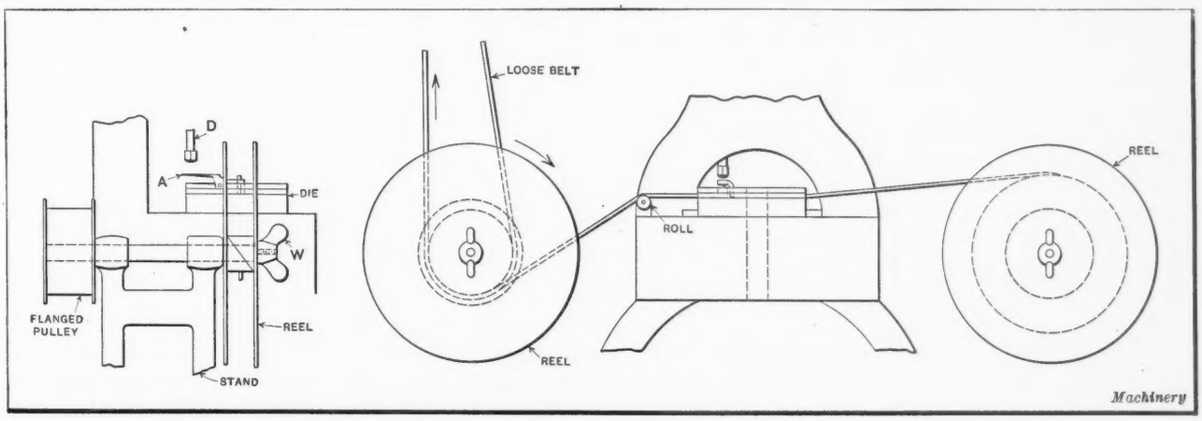
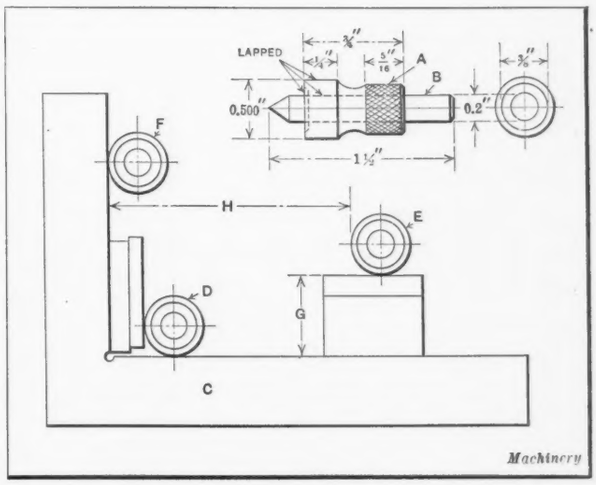


Fig. 2. Arrangement of Reels for Power Press Automatic Feed

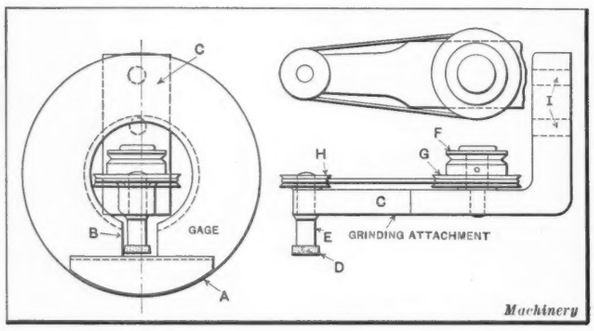


Combination Locating Button and Prick-punch, and Diagram showing Method of Application

SHOP AND DRAFTING-ROOM KINKS

GRINDING ATTACHMENT FOR BENCH LATHE

In making the special thread gage shown at *A* in the accompanying illustration, it was found necessary to grind the side *B* of the slot. To do this a special grinding fixture



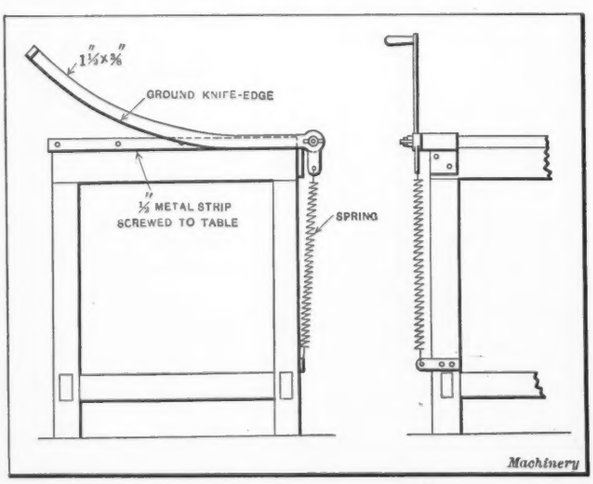
Bench Lathe Attachment for grinding Slot in Special Thread Gage

was devised and used as an attachment on a Pratt & Whitney bench lathe. The fixture consists of an arm *C*, an emery wheel *D* which is fastened to the spindle *E* with sealing wax, and three V-grooved pulleys *F*, *G*, and *H*. The pulley *F* is driven by a round belt from an overhead pulley, and transmits power to the grinding wheel by means of a similar round belt connecting pulleys *G* and *H*. For performing this job, the fixture was fastened to the milling attachment furnished with the lathe, by means of bolts passing through holes *I*. The gage was fastened to the faceplate, so as to permit the grinding wheel to gain access to the slot. The lathe spindle was then securely fastened to prevent it from turning, and the grinding wheel traversed over surface *B* until the necessary amount of metal was removed. This arrangement produced very satisfactory results.

Newark, N. J. JOHN A. SHAND

BLUEPRINT TRIMMER

The simple blueprint trimming device here illustrated has proved to be the means of saving considerable time when trimming large quantities of prints. A metal strip was screwed to the end of a table and a bracket was secured to the back of the table. A pin was then inserted in this bracket to support the knife, the cutting edge of which was properly



Simple Device for trimming Blueprints

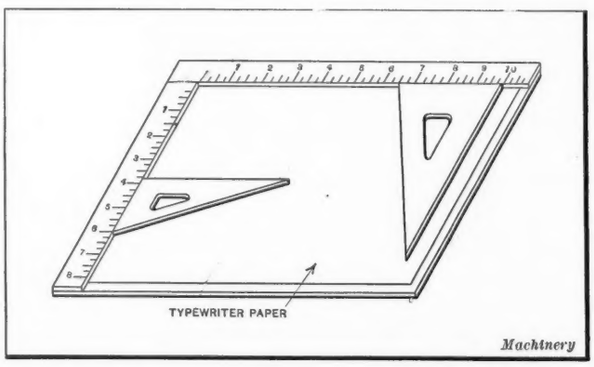
aligned with the metal strip. A compression spring, one end of which was secured to a lug on the bearing end of the knife, and the other end to a bracket on the table leg, pulls the knife upward after each cutting operation.

Toronto, Canada JAMES NELSON

DRAWING-BOARD FOR BRIEF CASE

The illustration shows a drawing-board of such size and weight that it can be conveniently carried in a brief case and used when a regular drawing-board is not available. It consists of a piece of seven-ply illustrating fiber board, 11¾ inches long by 9¼ inches wide, and two ¾-inch strips of the same material which are pasted along the upper and left-hand edges of the board. These strips are graduated in inches from the corner where they are joined, the horizontal strip being graduated from 1 to 11 inches and the vertical strip from 1 to 8 inches. The inch divisions are sub-divided into quarters of an inch. The weight of the board is approximately 3 ounces.

Any kind of paper may be used with the board, but its size is particularly adapted for sheets of typewriter paper. If two of the edges of the paper are placed along the strips,



Small Drawing-board which can be conveniently carried in a Brief Case

the paper will not have a tendency to move when the triangle is being shifted. This board is especially suitable to the work of field engineers, being of great assistance in making small sketches or preparing charts and data sheets.

New York City R. J. HOFFMAN

RESIZING WORN BRONZE BUSHINGS

Worn bronze bushings may often be satisfactorily resized by the following method, thus eliminating the necessity of replacing them with new ones. Remove the worn bronze bushing, sweat its outside surface with solder, and then press the bushing back into place. This will cause the bore of the bushing to contract and it can then be reamed to its original size.

New York City C. NYE

* * *

The British Engineering Standards Association has undertaken the standardization of spindle noses for milling machines. It is anticipated that when the new standards are finally decided upon, they will be widely adopted in Great Britain. Before such a standard is settled upon in Great Britain, however, it would be of great value if American milling machine manufacturers were consulted through the medium of the American Engineering Standards Committee, and if both countries could ultimately adopt a single standard.

HOW AND WHY

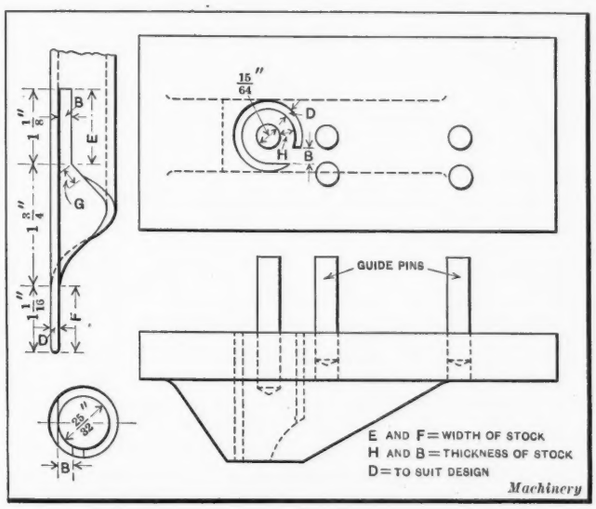
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRODUCTION PROBLEM FOR THE FORGE SHOP

H. C. T.—The end of a flat steel bar must be rolled to the shape and dimensions shown in the illustration which accompanies the original presentation of this problem, page 273 in the November number of MACHINERY. The end of the bar in which the eye is to be rolled has previously been hand-forged, but it is desired to increase production and decrease manufacturing expense by equipping a power press with suitable dies. This problem is submitted to the readers of MACHINERY with the hope that suggestions may be offered as to the construction of suitable dies to use and advice as to whether or not this job could be performed cold.

ANSWERED BY HARVEY MEAD

The forging equipment here shown is of a type that has been used successfully in bending large wire forms and



Forging Equipment for bending Eye in Flat Steel Bar

could probably be used in producing the piece in question from hot stock. The forging press plunger shown at the left in the illustration has a guiding extension, the length *F* of which is equal to the width of the stock. Immediately above this extension the stock of the cylindrical plunger is cut away spirally, as shown, so that its developed length is equal to that of the circumference of the eye to be formed. From the top of the spiral, a distance *G* slightly greater than the width of the stock serves to complete the closing-in of the eye, as will be explained later. From this point on, a slot is cut, the length *E* of which is equal to the width of the stock, and the width *B* equal to the thickness of the stock. The edges of the plunger should be rounded to prevent shearing, and the face of the spiral cut should be so backed off that the action of the plunger will permit the stock to be readily rolled.

The die used in connection with this forging equipment is of very simple construction and is shown at the right in the illustration. A circular slot is milled in the die, the width of which is sufficient to allow the plunger to operate freely within it. The metal which is left to connect the core made by this circular slot with the rest of the die is shown at *B*, its width being equal to that of the slot in the plunger and governed, of course, by the thickness of the stock. A pin of proper diameter around which the eye is rolled, is located in the center of this core as shown, the distance *H* being sufficient to permit the rolling of the stock. Pins for guiding and locating the stock are provided, and a reinforcing web is added to the bottom of the die, as shown, to provide strength for the area around the slot and center pin.

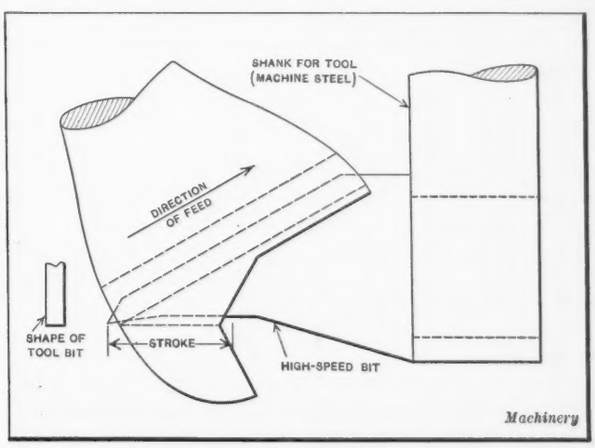
The operation of the plunger and die is as follows: As the plunger descends, the extension *F* enters the die first, preventing any tendency of the plunger to spring out of alignment. In continuing its descent, the spiral edge of the plunger contacts with the stock and rolls it around the pin. The section *G* serves the purpose of tightly closing the eye, preventing its gapping at the completion of the operation. Since there is a tendency for the stock to bend a little closer at the top than at the bottom, the plunger should travel over the stock farther than the mere length of the spiral, and hence the straight slot is provided in the plunger.

PRODUCTION PROBLEM FOR THE MACHINE SHOP

M. M. S.—What is the best method to employ, on a production basis, in removing stock from a wrench head in which the movable jaw of the wrench operates, as shown on page 1086 in the July number of MACHINERY? The stock removed forms a slot which cuts into the previously drilled hole for the jaw rack.

ANSWERED BY J. C. TONKIN, WALTHAM, MASS.

The following method may be employed with success to machine the wrench head. The work is to be performed on a shaper equipped with a fixture for holding the jaw in the position shown in the illustration and feeding it at an angle to the travel of the shaper ram. As a suggestion for the type of fixture to use, a plain milling machine vise might be employed, bolted to the side of the table, having screws to secure the work to the movable jaw of the vise, and fed by hand with the crank-handle of the vise. If so desired, a special fixture might be used having a slide and a



Arrangement for machining Wrench Head on Shaper

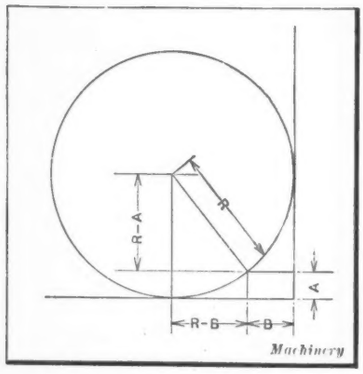
block for carrying the work, automatically fed by means of a cam designed so as to return the fixture to the loading position at the completion of the cut. This would permit loading without stopping the shaper. A special tool made to fit the toolpost of the shaper could be designed after the manner shown in the illustration.

The shank of this tool should be made of machine steel and carry a high-speed bit of the approximate shape shown, pinned or brazed to the tool shank. This arrangement should secure the desired result, and if the stroke of the shaper is sufficiently shortened, the work may be performed in production time.

TRIGONOMETRIC PROBLEM

F. E. M.—The diagram shows a disk which is laid against two surfaces located at right angles to each other. If a size block of known dimensions is placed as shown, how can the diameter of the disk be calculated which will be tangent to both sides, and to the corner of the block?

ANSWERED BY FREDERICK J. NAAB, PHILADELPHIA, PA.



The following solution of the above problem is simple, and does not involve complicated calculations. Referring to the diagram:

$$R^2 = (R-A)^2 + (R-B)^2$$

Expanding the above equation and solving for R,

$$R = A + B \pm \sqrt{2AB}$$

If, as in the previous solution of this problem in the January number of MACHINERY, we assume the dimensions of the size block to be $A = \frac{1}{4}$ inch and $B = \frac{1}{2}$ inch, and then apply the above formula,

$$R = 0.25 + 0.5 + \sqrt{2 \times 0.25 \times 0.5}$$
$$= 0.75 + \sqrt{0.25} = 1.25 \text{ inches}$$

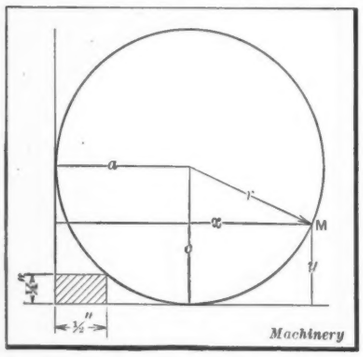
The diameter, therefore, equals 2×1.25 or 2.5 inches.

It is obvious that the conditions of the problem do not warrant using the minus value in the above algebraic equation as this condition does not apply. This solution is identical in principle with the one appearing on page 497 in the February number of MACHINERY.

ANSWERED BY V. CHARUSHIN, FITCHBURG, MASS.

The problem which appeared on page 459 of the January number of MACHINERY can be readily and simply solved by means of analytical geometry as follows: Draw the coordinates x and y from any point on the circumference of the circle, as M. Take the general equation of the circle

$$(x-a)^2 + (c-y)^2 = r^2$$



in which a and c are the coordinates of the center of a circle of radius r. According to the conditions of the problem $a = c = r$, and by substitution in the equation of the circle

$$(x-r)^2 + (r-y)^2 = r^2$$

or

$$r^2 - 2(x+y)r + x^2 + y^2 = 0$$

Assume that the dimensions of the block are the same as before, that is, ¼ inch thick and ½ inch wide; then, substituting these values in place of the coordinates x and y, and solving this quadratic equation, the value of r can be readily found. Thus,

$$r^2 - 1\tfrac{1}{2}r + 5/16 = 0; \text{ and } r = \tfrac{3}{4} \pm \sqrt{9/16 - 5/16}$$

Hence, $r = \frac{1}{4}$ inch or $1\frac{1}{4}$ inches.

It is quite obvious that of the two roots of the quadratic equation, the larger one applies to the conditions given.

DIFFERENCE BETWEEN STATIC AND RUNNING BALANCE

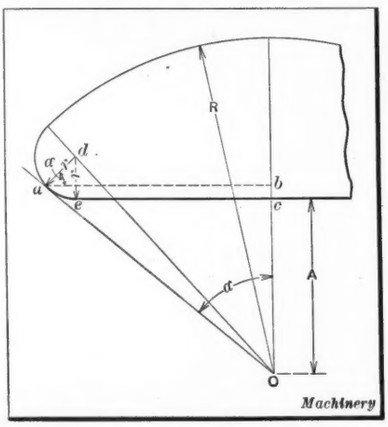
J. R. L.—What is the difference between a static balance and a running balance? If a part that is to revolve rapidly is in standing or static balance, will it also be in running balance?

A.—If a wheel, disk, or other body is mounted so that it is free to turn and will stand in any position, the part is said to be in standing or static balance. It does not follow, however, that the balance will be perfect when the part is revolving at high speed. If a thin disk is in static balance it will also be in a balanced state when revolving, but pulleys, drums, etc., especially if long in proportion to the diameter, may be decidedly out of balance at high speeds, even though the static balance is perfect. This is due to the fact that the unbalanced portions are at opposite ends or in different planes. To obtain a good running or dynamic balance, as it is also called, there should be a static balance in every plane at right angles to the axis of rotation.

MATHEMATICAL PROBLEM

ANSWERED BY JACOB YOUNG, WINTHROP, MASS.

A problem encountered in the design of a field pole tip was submitted to the readers of MACHINERY for solution in the January number of MACHINERY, page 459. The only known dimensions are the radius R, distance A, and the size of the angle a. It is required to find radius r of the arc.



Draw ab through point a parallel to the line ce. Then

$$Ob = A + bc = A + (r - r\sin a)$$

$$\cos a = \frac{Ob}{Oa} = \frac{A + r(1-\sin a)}{\sqrt{(Od)^2 - r^2}}$$

But

$$Od = R - r$$

Therefore

$$\text{Cos } a = \frac{A + r(1-\sin a)}{\sqrt{(R-r)^2 - r^2}} = \frac{A + r(1-\sin a)}{\sqrt{R^2 - 2Rr}}$$

Then, squaring the above equation and solving for r in terms of the known quantities A, R, and a, the resulting equation is

$$r = \frac{A(\sin a - 1) - R\cos^2 a}{(1-\sin a)^2} \pm \frac{\sqrt{[A(1-\sin a) + R\cos^2 a]^2 - (1-\sin a)^2(A^2 - R^2\cos^2 a)}}{(1-\sin a)^2}$$

Example—$A = 2$ inches; $R = 4$ inches; and $a = 45$ degrees; then, by substituting in the above equation, we find

$$r = 0.765 \text{ inch}$$

[A reply leading to a similar result has also been received from V. Charushin, Fitchburg, Mass., H. A. Randall, South Portland, Me., Charles Boehnlein, Minneapolis, Minn., Harry Levene, Philadelphia, Pa., Thomas A. Reilly, Hartford, Conn., A. J. Pruszyuski, Chicago, Ill., Otto H. Schafer, Detroit, Mich., and Elmer Latshaw, West Philadelphia, Pa.—EDITOR]

ANSWERED BY WILLIAM W. JOHNSON, CLEVELAND, OHIO

Referring to the diagram, angle $AOB = \beta$, and $BOC = a - \beta$; then from the right triangle OCB

$$r = \frac{R\sin(a-\beta)}{1+\sin(a-\beta)} \qquad (1)$$

In like manner from the right triangle OAB

$$r = \frac{R\cos\beta - a}{1+\cos\beta} \qquad (2)$$

From Equations (1) and (2), by comparison, it follows that

$$\frac{R\sin(a-\beta)}{1+\sin(a-\beta)} = \frac{R\cos\beta - a}{1+\cos\beta}$$

Clearing the above equation of fractions and simplifying,

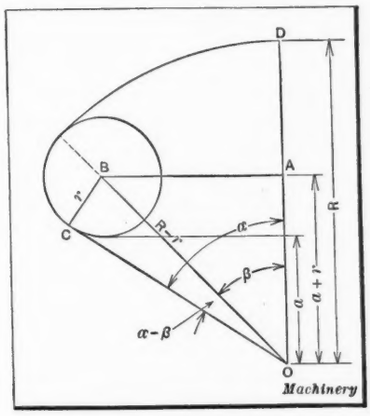
$$(R + a) \cos \alpha \sin \beta + [R - (R + a) \sin \alpha] \cos \beta = a$$

Dividing by $(R + a) \cos \alpha$ and cancelling,

$$\text{Sin } \beta + \frac{R - (R + a) \sin \alpha}{(R + a) \cos \alpha} \cos \beta = \frac{a}{(R + a) \cos \alpha}$$

In the above equation let

$$\frac{R - (R + a) \sin \alpha}{(R + a) \cos \alpha} = \tan \gamma$$



from which γ may be determined. Then, by substitution,

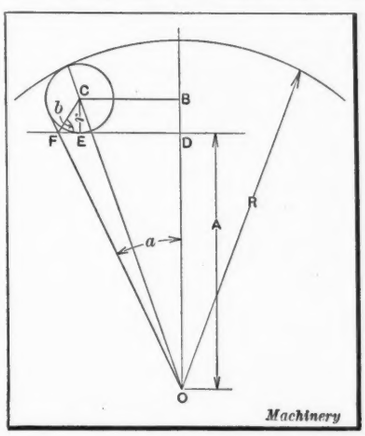
$$\text{Sin } \beta + \tan \gamma \cos \beta = \frac{a}{(R + a) \cos \alpha}$$

Multiplying this equation by cos γ, the equation may be written in the following form:

$$\text{Sin } (\beta + \gamma) = \frac{a \cos \gamma}{(R + a) \cos \alpha}$$

From the above, angle β may be found, and by substituting in Equation (2) the value of r may be readily determined.

ANSWERED BY FREDERICK J. NAAB, PHILADELPHIA, PA.



The problem encountered in designing a field pole tip, which was submitted in the January number of MACHINERY may be solved in the following manner:

Referring to the diagram, let $A = 7$ inches; $R = 10$ inches; and angle $a = 33$ degrees 38 minutes 40 seconds.

$$CB^2 = OC^2 - OB^2 = (R - r)^2 - (A + r)^2$$

$$= (10 - r)^2 - (7 + r)^2$$

Therefore

$$CB = \sqrt{51 - 34r}$$

In the triangle CFE, $FE = r \cot b$

but

$$b = \frac{90 \text{ deg.} + a}{2} = 61 \text{ degrees } 49 \text{ minutes } 20 \text{ seconds}$$

Therefore

$$FE = 0.5357r$$

In triangle FDO

$$FD = A \times \tan a = 7 \times 0.66552 = 4.6586 \text{ inches}$$

But $FD = FE + CB$; therefore by substituting the values previously found in this equation and solving for r,

$$4.6586 = 0.5357r + \sqrt{51 - 34r}$$

Transposing and squaring both sides of the equation

$$21.70255 - 4.99122r + 0.28697r^2 = 51 - 34r$$

from which $r = 1$, almost exactly.

INCLINATION OF TEETH ON SPIRAL END-MILLS

F. L.—Should the flutes of spiral end-milling cutters be right-hand or left-hand in the case of a right-hand cutter or one which revolves to the right as seen from the shank end?

A.—Theoretically, a right-hand cutter should have right-hand spiral flutes, as the teeth then have positive rake. Although, the right-hand flutes tend to pull the cutter out of the socket when used for side-milling, this disadvantage should not be allowed to outweigh the advantage of having the cutter teeth made with positive rake. It is good practice to hold the cutter firmly in the socket by means of a threaded rod which passes through the spindle and engages the end of the cutter shank, thus drawing the cutter firmly into the spindle socket. Many of the end-mills made by small tool manufacturers have a left-hand spiral for right-hand milling cutters and a right-hand spiral for left-hand cutters. The fact that the left-hand spiral on a right-hand mill tends to push the cutter firmly into the socket is often considered a greater advantage than the positive rake of the right-hand spiral on a right-hand cutter. This applies only when the cutter is used for milling slots and a considerable number of the axial teeth are engaged. If the mill is used as an end cutter only, then the spiral on the right-hand cutter should be right-handed, because the teeth then have a positive front rake. Some manufacturers of milling cutters prefer end-mills with teeth cut straight for ordinary use, in order to avoid the difficulties due to either the right-hand or left-hand spirals.

TO CARBURIZE COLD-ROLLED BALL RACES

F. M. C.—Can any reader of MACHINERY furnish information for carburizing cold-rolled ball races, so that they will be hard and tough but not brittle?

ANSWERED BY S. P. ROCKWELL, METALLURGIST WEEKES-HOFFMAN CO., SYRACUSE, N. Y.

In carburizing races for ball bearings, great care should be exercised because, unlike most work, the load is concentrated on a very small area and the case must support this load and at the same time resist the abrasive action caused by the rolling balls. The thickness of the case must be such that the load will not puncture it and impair the toughness furnished by the core. It is the usual practice among the manufacturers of ball bearings to provide a depth of case according to the rated load and thickness of stock. The depth of case being established, the most important consideration then is the determination of the carbon percentage of the case. By using a well proportioned carburizing material, of which there are many on the market, steel will carburize uniformly for various known temperatures. To raise the rate of penetration, the temperature is raised, which causes richer gases to be liberated from the carburizing material. The result is that instead of causing deeper penetration the gases will carburize the steel with a greater intensity, that is, with a higher percentage of carbon. Under ordinary conditions, the case may be considered as composed of three layers or laminations: (1) Hyper-eutectic steel, containing over 0.90 per cent carbon, composed of pearlite and free cementite; (2) eutectic steel, containing 0.80 to 0.90 per cent carbon, composed of pearlite; and (3) hypo-eutectic steel containing from 0.8 per cent carbon diminishing to the carbon content of the core. Cementite is 100 per cent brittle and is unannealable; therefore, for ball bearings and where rolling or sliding contact under heavy load occurs on small area, it should be avoided. Cementite forms no bond with the rest of the steel and when subjected to the strain of rolling contact, chips and cracks and causes pin marks. Pearlite is the most homogeneous constituent of the case and has the ability of holding this homogeneity when hardened; it gives the maximum hardness with the minimum amount of brittleness. It is this constituent, therefore, that is most desirable to produce in the case when hardening ball bearings. Nevertheless, since most ball bearings are ground after carburizing, a lamination containing excess free cementite is permissible, if the depth does not exceed the amount of grinding allowance.

Carburizing Materials and Methods

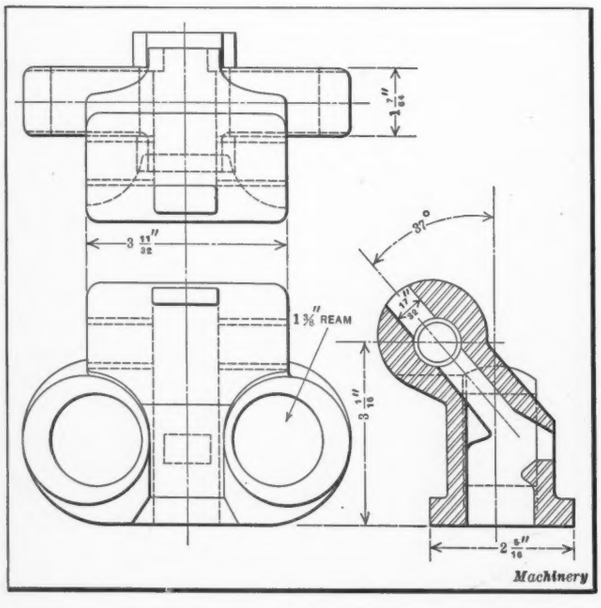
One manufacturer of carburized ball races buys carburizing material under the guarantee that 0.005 inch turned from a 1 inch diameter bar of low-carbon chromium steel, when carburized in the new mixture at 1650 degrees F. for a period of twenty-four hours, shall not contain over 1.10 per cent carbon, and not less than 0.95 per cent when the carburizing mixture contains one part new and four parts old. For ball bearings where the thickness of the case is from 1/32 to 3/64 inch, chemical carburizers such as barium salts, may be satisfactorily used at temperatures not exceeding 1625 degrees F., but for long heats, charcoal, and animal charcoal, sugar-bone, etc., (used with oil hydrocarbons) will undoubtedly produce the best results.

These carburizers have the properties of long endurance and minimum shrinkage, and at 1650 to 1700 degrees F. do not give off gases causing undue cementite formation. For long heats, fine carburizers are superior to the coarse material, on account of the shrinkage in the pack being less. The examination of the cross-section of pot-cooled work magnified to 100 diameters when polished and etched with a fluid of 10 per cent nitric acid and 90 per cent alcohol for a period of from ten to twenty seconds, will enable the different carbon zones to be determined so that the breadth of each may be measured.

Comparisons of several pieces of work carburized with different materials at different strengths, using different heats and different lengths of time, will soon disclose the best temperature and carburizer for producing the broadest eutectic zone and a hyper-eutectic zone not deeper than the specified grinding allowance. It is sometimes claimed that pitting, which really comes from poor heat-treatment, is caused by the carburizing material. When the work is pot-cooled and a single hardening resorted to, the different zones in the case will laminate. This may be avoided by pot-quenching and then refining the case by hardening; or by either pot-quenching or pot-cooling followed by first refining the core by hardening and then the case.

HEAT-TREATMENT PROBLEM

A. M. C.—We have experienced considerable difficulty in carburizing and casehardening chain blocks of the general dimensions and design indicated by the accompanying illustration. These blocks are steel castings having from 0.20 to 0.30 per cent carbon. It is required to obtain the greatest tensile strength together with a depth of casehardening of approximately 1/32 inch.



A GEOMETRICAL PROBLEM

ANSWERED BY J. OLSON, ROCHESTER, N. Y.

Referring to the solution of the geometrical problem, published in the November number of MACHINERY, page 273, the following suggestion is offered. The conditions of the problem require that the lengths x and y (see accompanying illustration) be determined, the only known elements of the triangle being the lengths of the three sides. A convenient method to use in the solution of this problem involves the following geometrical proposition: In any oblique triangle where the three sides are known, the ratio of the length of the base to the sum of the other two sides equals the ratio of the difference between the length of the two sides to the difference between the lengths x and y.

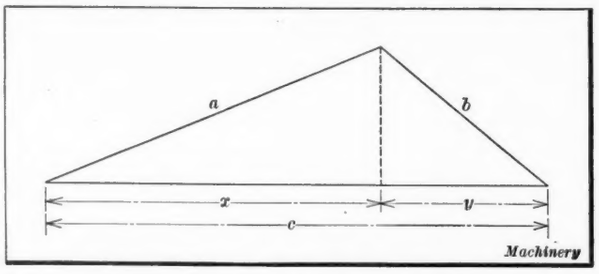


Diagram used in Connection with Problem in Geometry

Therefore, if in the accompanying diagram, $a = 14$, $b = 12$ and $c = 16$ inches, then

$$c : (a + b) = (a - b) : (x - y)$$

$$16 : 26 = 2 : (x - y)$$

$$(x - y) = \frac{26 \times 2}{16} = 3\frac{1}{4} \text{ inches}$$

But

$$x = \frac{(x + y) + (x - y)}{2} = \frac{16 + 3\frac{1}{4}}{2} = 9.625 \text{ inches}$$

and

$$y = \frac{(x + y) - (x - y)}{2} = \frac{16 - 3\frac{1}{4}}{2} = 6.375 \text{ inches}$$

HEAT-TREATMENT FOR GEARS

ANSWERED BY EDWARD J. RANTSCH, BROOKLYN, N. Y.

The following information relative to the heat-treatment of clashing tractor transmission gears is given in reply to the questions submitted by P. H. B. in the January number of MACHINERY, on page 459. The writer would say from his experience in the heat-treatment of chrome-nickel steel gears, intended to withstand sudden shock and stand up under severe conditions, that the following method would give P. H. B. satisfactory results.

In order to treat gears of 8 diametral pitch so that they will have a soft core suitable to withstand shock, first heat the gears in carburizing pots to 1600 degrees F. for seven hours. Then remove the pots from the furnace and allow the box and work to cool over night. The next morning empty the pots and reheat the gears to 1400 degrees F. Then take out and quench in oil. This is known as the refining heat. Reheat the gears to 1450 degrees F. and quench in water, and the gears will be found to be properly hardened. Several gears should be treated in this way, and the teeth should be broken from one in order to ascertain the depth of case on the teeth, which should be 1/32 inch. The analysis of the steel used by P. H. B. shows that the steel is suited to the requirements specified. In reference to the gears that have already been heat-treated, it is the writer's opinion that they should be scrapped, as the carburizing has penetrated entirely through the steel, thus making it practically a tool steel which cannot be used with success for the purpose for which it is intended in this case.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool Descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

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Hanson-Whitney Tool and Die Shaper

This machine is adapted for the performance of shaping operations on various types of tools and dies. Although it is of comparatively small size, sufficient range is provided for handling a variety of classes of work. In designing this machine special attention was given to the development of means for accurately controlling its functions so that precision work can be performed on it within close limits. Rapid ram travel permits a high rate of output.

TO meet modern requirements in the manufacture of fine tools the Hanson-Whitney Machine Co., Hartford, Conn., has recently started to build a vertical tool and die shaper. This machine is especially suited for use in making punches and dies of various types which are widely used in the production of parts for electrical appliances, typewriters, adding machines, clocks, watches, etc. Although it is of comparatively small size, sufficient range is provided to enable large sized dies to be swung in all directions without interference; on the other hand, it is claimed that small tools for precision operations can be used with the utmost sensitiveness. In working out the design of this machine, especial attention was given to the development of means for accurately controlling all of the functions, so that the most refined work can be done under conditions that enable the operator to depend upon the machine holding his work within close limits. The ram travels very rapidly, thus increasing the rate of output.

Liberally proportioned bearings support the vertical slide or ram and the knee is rigidly secured to the column, being guided at the center by a dovetail and locked at the edges with square locks. The working slides are furnished with narrow guides, and for the size of the machine, they have a large range of action. A combination of flat and tapered bearings supports the rotary table which has an indexing mechanism of the same type that is employed on a universal milling machine. An automatic feed is provided for both slides, and the feed in all cases occurs on the return stroke of the ram. There are several features of the design of this machine which are believed to be entirely new. Among these mention may be made of the following: Provision is made for adjusting the length of stroke, regardless of whether the machine is running or at rest, and such adjustments can be made with equal facility under either condition. Variations in the length of stroke are accomplished by a handwheel shown at the side of the column just back of the ram, the mechanism used for this purpose being of simple and durable construction. When the machine is stopped, the ram will automatically come to rest at the top of its stroke. The handle shown on the right-hand side of the column is pulled toward the operator to start the machine, and this handle is pushed back into the position shown in Fig. 1 to bring the machine to rest. No matter when this is done the ram will stop at the end of its up stroke. On the back stroke, the tool positively recedes from the work, and on the down stroke it is returned to the operating position. In this way no

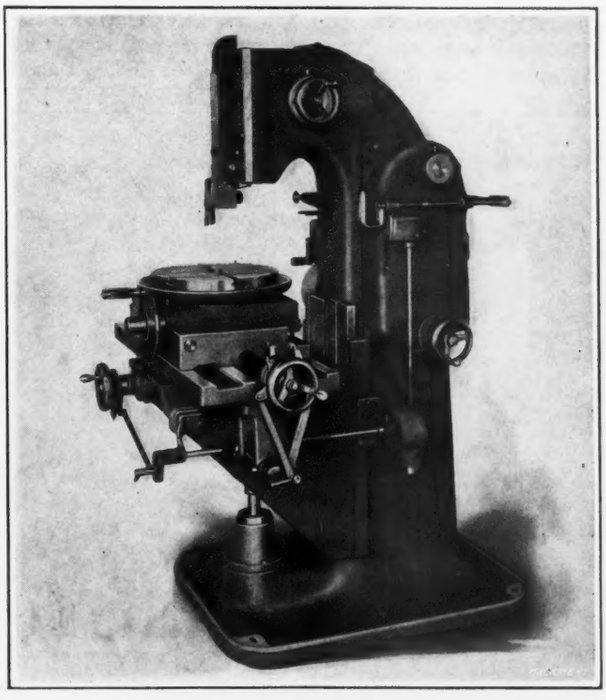


Fig. 1. Vertical Tool and Die Shaper built by the Hanson-Whitney Machine Co.

trouble is experienced through dragging the edge of the tool over the piece that is being machined.

By examining the construction of the tool-holder, it will be seen that there is no set-screw or any other projecting member to prevent the ram from clearing the work. In other words, a long overhang of the tool is not necessary when planing the outside of a piece, and when planing on the inside of a die or similar part, it is only necessary to have the overhang of the tool as long as the cut which is to be taken. The standard tool is made with a clearance as illustrated in Fig. 2, and when sharpened it only needs to be ground at the end. Various shaped tools can be made to meet the requirements of different jobs such as square-nose, round-nose, diamond-point, etc. All working surfaces, in connection with the clapper mechanism, are made of hardened and ground steel. In addition to the rotary motion of the table, it can also be tilted so that when making dies, where a clearance is desired, this result can be easily obtained, a segment graduated in degrees indicating the amount of taper that is necessary. Feed-screws on the slides have the usual micrometer dials graduated to 0.001 inch.

Three changes of speed are provided in the driving mechanism which receives power from a tight and loose pulley on the left-hand side of the column. No countershaft is necessary, as the machine can be driven directly from the main lineshaft. An interlocking device in the speed change mechanism enables shifting to be done without danger of injuring the gears. The fast driving pulley may be running constantly and a speed will be engaged by the handle at the right-hand side of the machine, of which mention has already been made, which engages the ram motion through an expanding friction clutch without shock or noise. About one-half way down on the right-hand side of the column there is a handwheel that can be engaged with the mechanism when the machine is at rest, to provide for turning the machine by hand while setting up a piece of work to make sure that there is no interference. The knee may be adjusted relative to the positioning of the stroke. Fig. 2 shows a work vise of substantial construction which is made for holding small pieces of work, the design of this tool being distinguished by the fact that it has two gaps, one of which is capable of opening up to 2 inches, and the other up to 4 inches. This vise is finished all over, and has hardened and ground jaws. A tool-holder for securing small tools and other work on the machine is also made to special order.

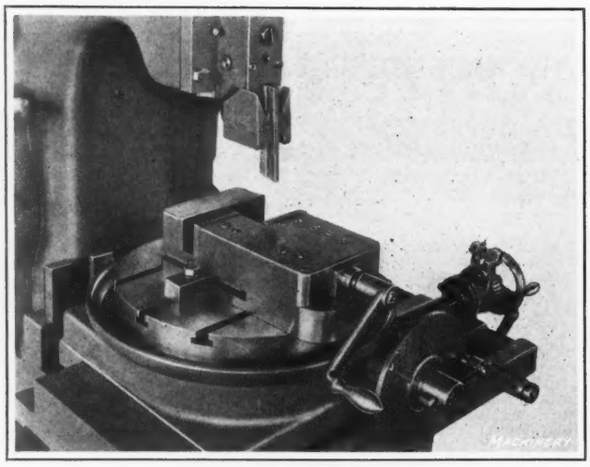


Fig. 2. Close-up View of the Table, Cutter, etc., on the Hanson-Whitney Vertical Tool and Die Shaper

Dies of the types which are machined on this vertical tool and die shaper are finding a steadily increased application in industrial plants that are engaged in the manufacture of a diversity of products.

ROCKFORD NO. 3 MILLING MACHINE

In working out the design of a No. 3 all-geared milling machine which has recently been developed by the Rockford Milling Machine Co., Rockford, Ill., an effort has been made to combine in its mechanism features which will assure a maximum productive capacity for a machine of this size with the greatest possible convenience of operation. In order to adapt this miller for handling either tool-room or production work, it was necessary to not only provide for the attainment of a high degree of accuracy but also to furnish ample power and rigidity for taking heavy cuts at high speed and coarse feed. An all-geared drive assures the positive transmission of power, and especial care has been taken in arranging cross-ribs at the base of the column in order to stiffen the construction and afford sufficient rigidity to withstand stresses set up by the most severe classes of service.

Another highly important feature in adapting this miller for the efficient performance of manufacturing operations is the arrangement that has been made for clamping the knee to the column through tightening the nuts shown at *A* and *B* in Fig. 2, and for securing the saddle in a fixed position on the knee by screwing down nut *C*. Where a machine is engaged on repetition work, movement of these members is not required, and by clamping them in the manner just men-

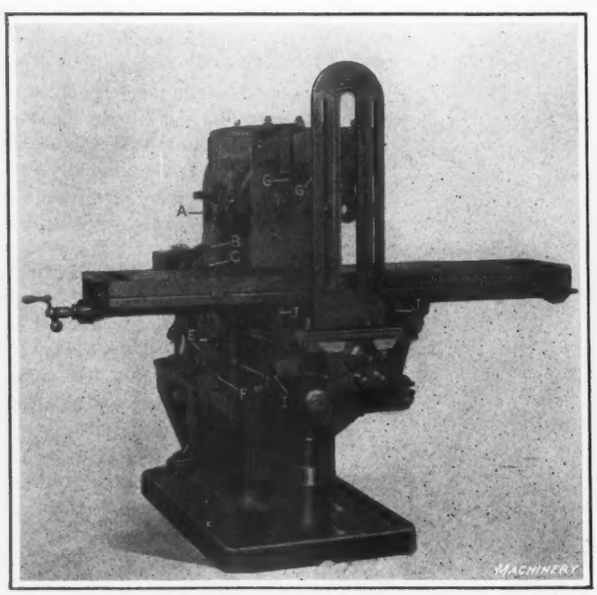


Fig. 1. No. 3 Milling Machine built by the Rockford Milling Machine Co., showing Control Levers for the Speed and Feed Changes, etc.

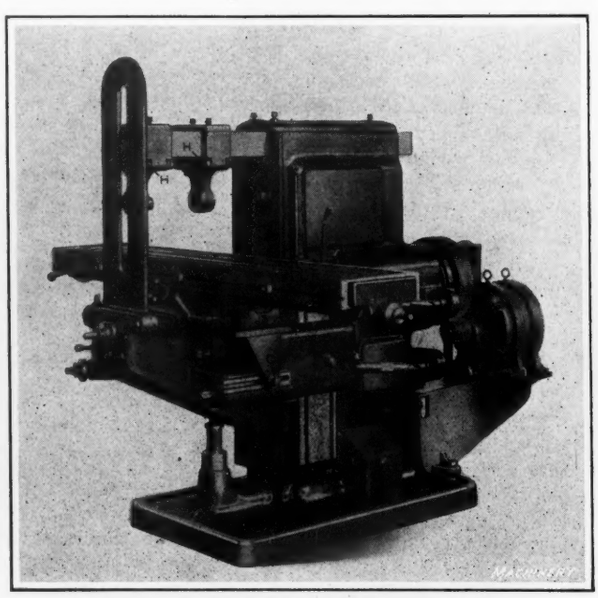


Fig. 2. Opposite Side of Rockford No. 3 Miller showing Motor Drive and Method of clamping the Knee to the Column and the Saddle to the Knee

tioned a degree of rigidity comparable to the Lincoln type of machine is attainable for handling production milling under severe operating conditions. As regards convenience of manipulation, attention is called to the fact that all of the control members for obtaining changes of speed and feed are centralized at the side of the column, as shown in Fig. 1, where they are within easy reach of the operator; and there is a clutch lever at each side of the machine, so that provision is made for instantly starting or stopping after the operator has his job set up. Mention was made of the care that has been taken in bracing the column at its base in order to afford the degree of rigidity that is required for heavy manufacturing work; but this is also an important factor in enabling the machine to handle accurate tool-room milling operations, because it assures a perfect uniformity of movement in elevating the knee. Failure of similar numbers of revolutions of the screw to cause exactly equal degrees of movement of the knee would necessarily be reflected in corresponding errors in the accuracy of the work.

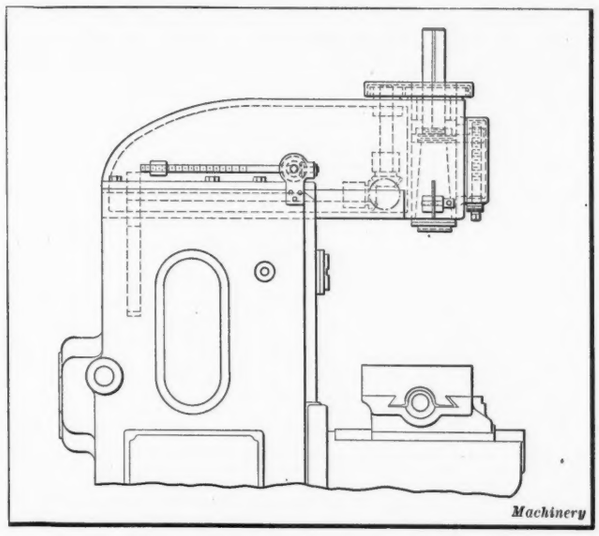


Fig. 3. Gear-driven Vertical Attachment for the No. 3 Rockford Miller

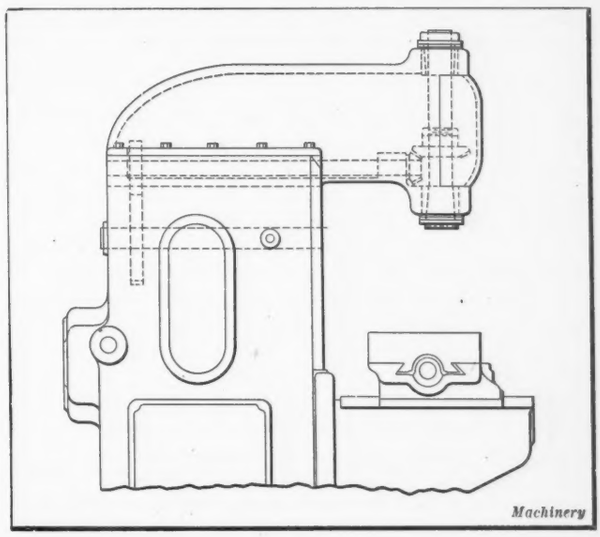


Fig. 4. Vertical Attachment with a More Simple Arrangement of Gearing

Arrangement of Geared Drive to Spindle

According to the requirements of the consignee, a machine of this type may be arranged with single pulley drive or with an individual electric motor direct-connected to the machine, the latter type of drive being shown in the accompanying illustrations. An unusual method is employed for obtaining changes of spindle speeds in the gearing provided on the machine for that purpose. This will be best understood by referring to Figs. 1 and 5 which show the side of the milling machine on which the control mechanism is located and a cross-sectional view through the speed gearing. Mounted inside the column of the machine there is a cone of three gears, *A*, *B*, and *C*, carried by an arm which is arranged to rock about one of the intermediate driving shafts, a pinion on this shaft transmitting power to the cone of three gears. Provision is made for rocking these gears over to engage either of the two gears *D* and *E* which are splined to slide on shaft *F*. Particular attention is called to the fact that the cone of gears *DE* slides on its shaft which is free to rotate but occupies a fixed position otherwise; and that the cone of gears *ABC* rotates on its shaft which is free to swing, but there is no endwise movement.

To the right of gears *DE* on shaft *F* it will be seen that there are two gears *GH* which are mounted in a fixed position on the shaft; and still further to the right there is a pinion *I*, the teeth of which are cut in an integral part of the shaft upset for that purpose. This pinion meshes with teeth in gear *K*, which is loosely mounted on the milling machine spindle. Carried on the spindle behind the gear *K* there are two sliding gears *L* and *M* which are arranged to mesh with gears *G* and *H*, respectively, and by sliding these gears still further to the right than the position which they occupy in the illustration, pins *N* enter holes cut in the side of gear *L* for that purpose. It will be noticed that there are compression springs behind pins *N*, and when the gears are pushed to the right the pins move into the gear *K* against the compression of these springs. Then, as gear *L* rotates so that the holes come opposite the pins, they snap into place and provide a direct clutch connection between the gears *K* and *L*.

Having made a general statement of the way in which the speed mechanism functions, a brief review will make it apparent that three changes of speed are provided by gears *A*, *B*, and *C*. Gears *D* and *E* multiply this number by two, making a total of six changes, and the pairs of gears *LG*, *MH*, and the clutch pins *N*, introduce a multiplying factor of three, thus making a total number of eighteen speed changes available on the machine. These changes of speed are in geometrical progression and cover a range from 15 to 360 revolutions per minute. Referring to Fig. 1, attention is called to the fact that an index-lever moving over three-station dial *A* provides for sliding the cone of gears *LM* (Fig. 5) to mesh with gears *GH* or to make direct connection through pins *N*. The horizontal speed-change mechanism *B*, with six stations, provides for setting the control lever that manipulates gears *DE* to engage either of these gears in any desired position on the cone *ABC;* and a six-station dial *C* provides for rocking the cone of gears *ABC* (Fig. 5) into either of the desired positions to mesh with gears *DE*.

Arrangement of the Feed Mechanism

A somewhat similar arrangement to the one shown in Fig. 5 for controlling the speed changes is employed for obtaining the required variations of feed on the Rockford miller. The mechanism employed for this purpose consists of a cone of four gears carried by a rocker arm, with provision for driving this unit of four gears at either of two speeds. This cone of gears rocks but occupies a fixed longitudinal position. On the driven shaft there is also a cone of four gears which are splined to slide on their shaft, so that the largest gear on each cone may be brought into mesh with either of the gears on the other cone.

From this general outline of the method of operation, it will be evident that two changes of feed are made available through the two preliminary speeds at which the first cone of gears may be driven, and seven changes of feed are secured by the possible combinations in which the largest gear on each cone may be meshed with the remaining gears of the other cone. As a result, there is a total of fourteen changes of feed covering a range from 9/16 inch to 18 inches per minute. At the bottom of the milling machine column, there will be seen a dial *D* in Fig. 1, that has two stations and

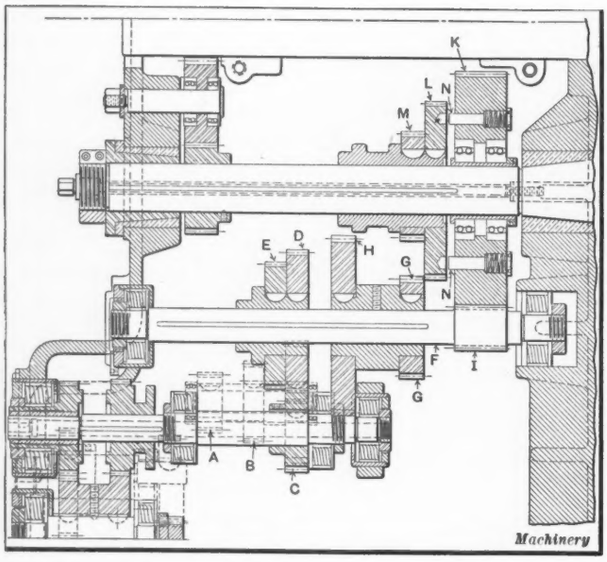


Fig. 5. Arrangement of Gears for obtaining Changes of Speed

a lever for sliding two gears which drive the swinging cone of gears at different rates of rotation. The lever running over dial *E* provides for rocking this cone into the proper positions for meshing with either of these two gears; and the lever running over seven-station dial *F* provides for sliding the other cone of gears into the proper positions for meshing with the different gears on the swinging cone.

All mechanics who read this article will at once be impressed by the form of over-arm construction which is shown in the illustrations. Mention has already been made of features of the design which adapt this miller for the efficient performance of production work, but the discussion of this subject would be incomplete without calling attention to the fact that the liberally proportioned over-arm of rectangular form not only affords ample metal for resisting strains resulting from the pressure of the cutter on the work, but that the rectangular form of the arm also affords a datum surface that is useful in setting up gages and other tools used in making measurements and for locating holes while performing precision tool-room milling operations.

Another convenient feature is that by simply removing a screw, shown at *G* in Fig. 1, the arbor support may be swung on pivot *H*, Fig. 2, to get it out of the operator's way. A three-step dial *I*, Fig. 1, provides for forward or reverse movements of the feed, and levers *J* govern the forward and reverse movement of the rapid traverse. Figs. 3 and 4 show two different types of vertical milling attachments which are available for use on this milling machine. While the term "attachment" is used, it is really somewhat of a misnomer because the bearing for the rectangular shaped over-arm used on the horizontal machine may be removed and the vertical attachment substituted in its place in a manner which produces a vertical milling machine that is just as much of a standard machine tool of its type as the horizontal machine is representative of millers of this class.

AUTOMATIC THREAD MILLING MACHINE

To provide for the rapid performance of thread milling operations on various metal products, the Automatic Machine Co., Bridgeport, Conn., has recently developed a machine which is here illustrated and described. This thread miller is adapted for internal or external work, and taper or straight threading, and it should be noted that all movements are automatic, with the exception of backing the cutter-spindle away from the work after the operation has been completed. From Figs. 1 and 2, it will be apparent that a liberal sized opening is provided through the work-holding spindle, making it possible for long pieces of considerable size to project back through the spindle, so that a thread may be milled at the forward end of the work. Various forms of chucks, collets, expanding arbors etc., may be provided on this machine to adapt it for handling thread milling operations on a wide range of work. This work-spindle swivels to provide for cutting tapered threads or to allow for making adjustments, so that a perfectly true straight thread can be cut, even though the high-speed steel cutting hob has not been welded squarely on the soft steel shank.

Before starting upon a discussion of the way in which the different movements are automatically obtained on this thread miller, attention is called to the fact that it is a production machine, and is ordinarily used continuously for the same work. On that account it was not considered that the expense of a speed-changing mechanism would be justified. Power for driving the work-spindle and related parts is furnished by a belt running over a two-step pulley at the head end of the machine. From this pulley power is transmitted through spur gears *A*, and a worm and wheel *B* to a vertical shaft, from which the drive is transmitted to the work-spindle through a second worm and worm-wheel.

Carried by this vertical shaft there is also another worm that meshes with worm-wheel *C* to provide for transmitting power to camshaft *D* that runs along the back of the machine. Two cams *E* and *F* are mounted on this shaft. Face cam *E* provides for imparting a longitudinal feed movement to the cutter-slide, corresponding to one pitch of the thread to be milled, during the period that the work is making one and one-tenth revolutions; and cam *F* has a concentric surface running practically all the way around its circumference which holds the cutter in to the required depth for milling the thread. As shown in the plan view of the machine, Fig. 3, it will be seen that there is a sudden drop in this cam which allows the cutter to recede from the work immediately after the milling operation is completed, and the operator then withdraws the cutter-spindle carriage from the work by means of hand-lever *G*, so as to allow ready access to the work-spindle if the chucking happens to be from the front instead of from the rear of the work-spindle.

On the top of lever *G* it will be seen that there is a small rod *H*, actuated by a thumb-lever, which lifts a latch that drops into a hole in the machine frame to hold the cutter-spindle back from the work while the operator is engaged in removing the milled piece from the chuck and setting up a fresh blank in its place. A counterweight and cable draw the cutter-slide forward when the operator re-

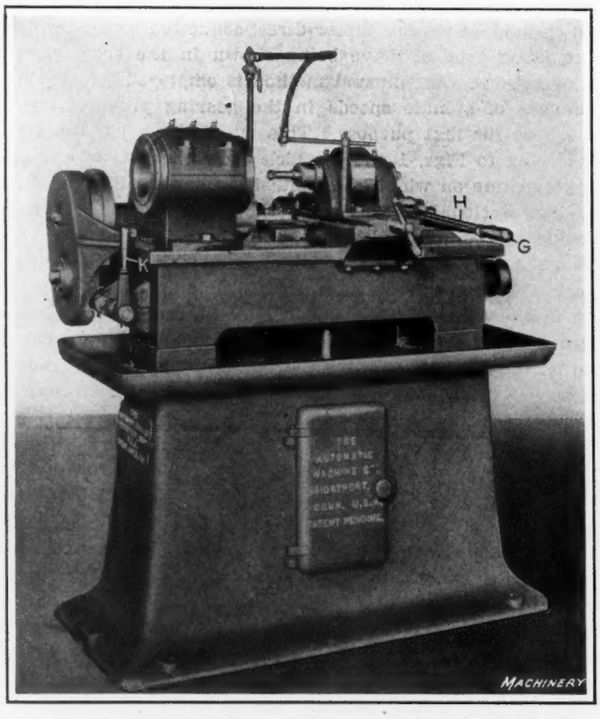


Fig. 1. Thread Milling Machine built by the Automatic Machine Co.

leases the latch, this movement bringing the cutter into the desired position for starting the thread milling operation, since the face cam acts also as a positive stop. In Fig. 3, attention is called to the fact that bronze block *I* is secured to the cutter-carriage, and it is this block that projects beyond the guard over cam *E* and comes into engagement with the throw of the cam, which is indicated by a dotted line. This imparts the necessary longitudinal feed movement to the cutter, and the broad surface of this shoe, instead of the line contact of a roller, eliminates possibilities of trouble from surface irregularities on the face cam.

Similarly, bronze block *J* on the cross-slide of the cutter-carriage engages cam *F* to provide for feeding the cutter into the work. Cams *E* and *F* are so synchronized that when the cutter has been fed across the work a distance corresponding to one pitch of the thread, cam *F* will have fed the cutter in to depth and come around to bring the notch or drop on the cam into contact with block *J*. When this point is reached, the cutter recedes from the work automatically and the operator withdraws the cutter-slide by manipulating handle *G* for chucking the next piece.

In order to obtain the desired results in the operation of a thread milling machine of this kind, it is important for the work to make just in excess of one complete revolution and then for rotation of the work to be stopped. This result is accomplished by incorporating an ordinary power press latch mechanism on the main driving pulley. The latch utilized for this purpose is shown at *L* and it enters a notch in the pulley, which is also clearly illustrated. In starting the machine the operator throws over lever *K* and the work will then rotate through the required distance, when latch *L* will come into engagement and stop further movement.

Contained in the bed of the machine there is a reservoir for the oil or emulsion that is used to cool and lubricate the cutter and work. The pump for circulating this coolant is belt-driven from the countershaft, and Figs. 2 and 3 clearly show the arrangement of the pump and piping. The relief pipe discharges directly into the reservoir again instead of into the pan. The milling-cutter spindle, which is running continuously, is driven by an independent belt from the countershaft, as a fairly high speed of rotation is required for the milling cutter, which is usually of quite a small diameter.

As previously mentioned, this is a production machine,

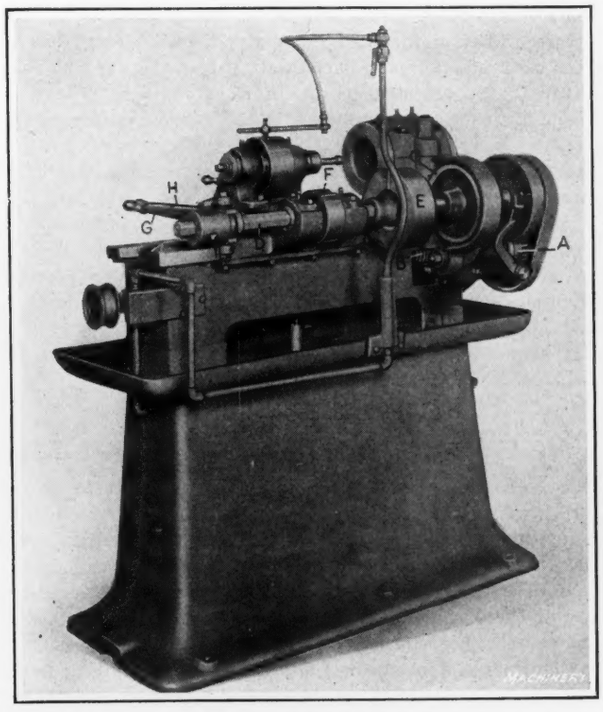


Fig. 2. Rear View of the Automatic Thread Milling Machine shown in Fig. 1

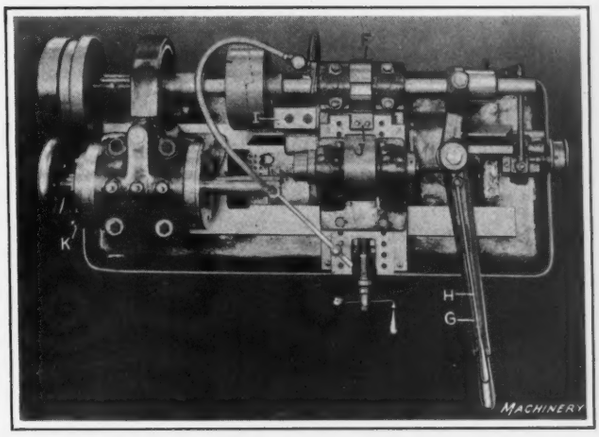


Fig. 3. Top View of the Automatic Thread Milling Machine

generally used continuously on a single class of work, and hence it was not considered desirable to put the customer to the expense of a speed-changing mechanism. It is usual for information to be sent to the Automatic Machine Co. concerning the class of work that is to be done on the machine, and with such information available, suitable gears are placed in train *A* to give the required speed of rotation to the work. Gears for this purpose are made in a standardized range of sizes, so that it is merely a question of selecting those gears which will cause the work to revolve at a suitable rate.

It will be evident that the automatic features of this machine eliminate hand operations and enable one operator to tend to several machines at the same time.

LEEDS & NORTHRUP HUMP METHOD FOR HEAT-TREATING STEEL

A new method for the heat-treatment of steel has recently been introduced by the Leeds & Northrup Co., Philadelphia, Pa., which represents an important development in hardening-room practice. It is known as the hump method, and utilizes the outward manifestation of changes in internal structure which take place when steel is heated past the so-called critical or transformation point to indicate when the work should be withdrawn from the furnace. In using this method, the temperature of the furnace, and therefore of the work, is raised at a uniform rate until the transformation point of the steel is reached. At this time there will be a marked decrease in the rate of temperature rise. This change in the rate of rise is made plainly visible to the operator by an autographic recorder connected to a thermocouple placed close to or in contact with the work. The effect is clearly shown by a bend or hump in the curve as shown in Fig. 1. This hump corresponds to a pause in temperature rise or decrease in the rate of heating of the steel, which occurs in spite of the fact that heat is being transferred to the work during this interval as rapidly as before or after. It is explained by metallurgists as being due to the dissolving of cementite or carbide of iron in the pure iron or ferrite, and to other chemical and physical changes depending upon the composition of the steel. By microscopical and chemical means, it is known that the physical and chemical structure of steel after quenching is profoundly influenced by the relative time of quenching with respect to the time at which the arrest occurs. The hardness, strength, ductility and toughness are all definitely influenced.

As a guide in hardening, the temperature pause or decalescence point, as it is called, is claimed by the Leeds & Northrup Co. to be much more reliable than is the furnace temperature as indicated by a pyrometer. The arrest in temperature, as signaled by the hump or bend in the line drawn by the pyrometer pen, shows that the internal changes affecting the qualities of the finished steel, are actually

taking place, and once the proper subsequent interval to allow before quenching has been determined, there is no uncertainty about the results of hardening. The user of the hump method need not concern himself about the absolute accuracy of his pyrometer, nor bother with independent transformation point determinations. It is not at all necessary that the temperature indicated by the thermo-couple should be the correct temperature of the work, for so long as the recorder connected to the thermo-couple shows clearly the pause in temperature rise, the moment at which transformation occurs is definitely known. Having learned by trial just how many minutes should elapse after the beginning or end of the transformation before the work is removed from the furnace, he is upon sure ground and can repeat results. Uniform standardized conditions and a control of the rate of heating the work are essential to the hump method of heat-treatment. The heating element consists of a vertical, cylindrical resistor, surrounded by insulating material in a sheet-iron jacket. The resistor rests upon a refractory block, which is supported by a cast-iron bottom plate. The heating chamber is closed at the top by a refractory cover, while a cast-iron top plate confines the loose insulating material, filling the space between resistor and jacket. An iron-constantin thermo-couple of bare No. 8 gage wire projects upward from the center of the bottom refractory block.

By means of a small wire attached to a tool support on the top plate of the furnace, the work to be treated can be suspended in close proximity to, or touching, the end of the thermo-couple. In production furnaces other methods of supporting the work are used. For example, in a furnace that is especially designed for heat-treatment of automobile transmission gears, the work is placed upon holders before insertion in the furnace. Covers placed on the furnace completely close in the heating chamber, preventing renewal of the atmosphere, and the work is thus protected against oxidation and scaling. At the moment when the work is introduced into the furnace, the temperature of the latter is, say, 1400 degrees F., but the heat storage capacity of the furnace walls being small compared with that of the charge, the temperatures of both thermo-couple and furnace walls drop rapidly a few hundred degrees, the current through the heating element or resistor being shut off during this time. The result can be seen in the chart made by a curve-drawing pyrometer connected to a thermo-couple located in a furnace operated in the manner just described, as reproduced in Fig.

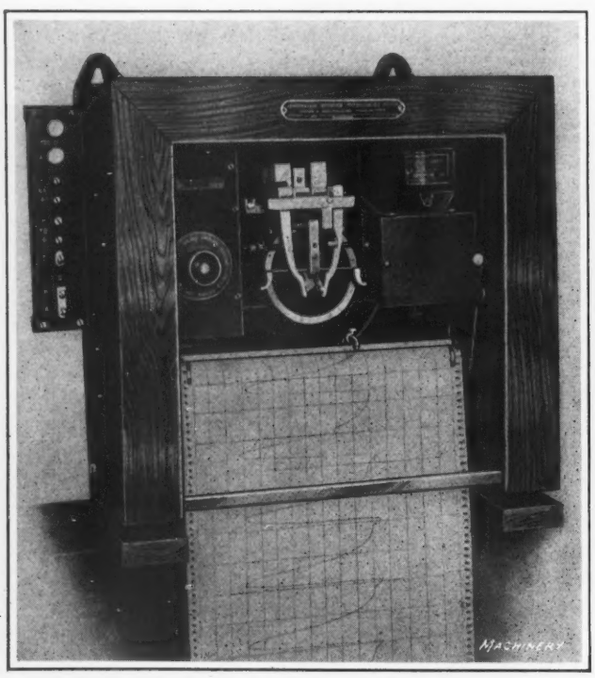


Fig. 1. Recording Pyrometer made by the Leeds & Northrup Co., which is used in applying the Hump Method of heat-treating Steel

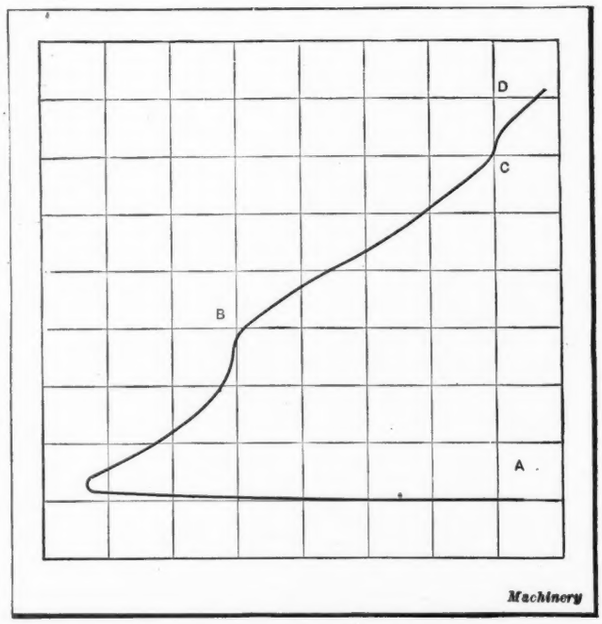


Fig. 2. Diagram showing how the "Hump" is produced on the Recording Pyrometer Chart

2. The temperature drops rapidly from 1400 degrees F. at *A* to about 870 degrees F., and then rises slowly to *B*, where it is stationary, the thermo-couple, furnace walls, and all parts, small and large, of the charge having reached approximately the same temperature. The switch is then closed, the input being so regulated that the temperature rises at the desired rate. The fact that the work and furnace start from the same temperature at *B*, far below the critical point, coupled with a proper arrangement of the heating element, with respect to the charge, insures that all parts of the work will go through the critical point at the same time. This is desirable in order to avoid stresses and distortion that would follow from unequal expansion or contraction if different parts of the work passed through the transformation point at different times.

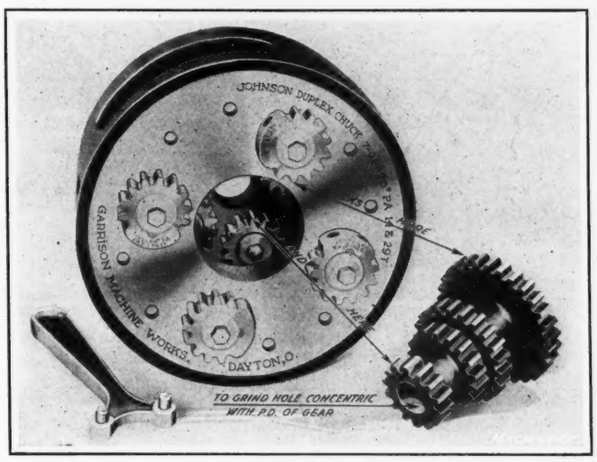
The arrival of the work at the transformation point *C* causes an abrupt change in the rate of heating, due to the suddenly increased capacity of the steel to store heat. The temperature stops rising or proceeds much more slowly than before, although the rate of supply of heat energy has not been changed; however, once the transformation is completed, as at *D*, the temperature again rises rapidly. The pause is plainly shown by the hump in the curve. Before quenching, it is necessary to heat the work for a certain time after this point, the time depending on the mass and shape of the steel, the quenching medium employed, and the qualities desired. The exact further heating to be allowed after the completion of the transformation point is learned by experience or trial, but once known, all uncertainty as to the result is practically eliminated. In using the hump method, the metal is quenched without hesitation, as soon as the pen has gone the prescribed distance past the "hump," which indicates the transformation point.

GARRISON DUPLEX GEAR CHUCK

A duplex gear chuck for holding cluster gears to provide for grinding the bore concentrically with the pitch circle is a recent product of the Garrison Machine Works, Dayton, Ohio. This chuck makes it unnecessary to trust the judgment or skill of the grinder hand. In setting up a cluster gear in one of these chucks provision is made for holding the two end or outer gears of any cluster, and the number of gears in the cluster, the design, or the pitch is not a limiting factor. This duplex gear chuck can be applied to a grinding machine the same as any ordinary chuck through the use of an adapter or by attaching it to the faceplate. The chuck con-

sists of front and rear units secured together by a container which is rigidly attached to the rear unit and bored to receive the front unit. The front chucking unit is free to rotate in its container.

Rotating the front chucking unit in a forward direction simultaneously locates and chucks the front and rear gears of the cluster with an automatically balanced pressure; and a reverse movement of the front chucking unit simultaneously opens both the front and rear units, so that the gear may be removed from the chuck. The average chucking time is said to be from 5 to 8 seconds. These chucks will hold gears from $+0.010$ to -0.020 inch on the pitch diameter and they are guaranteed to chuck the gear so that eccentricity of the pitch line will not exceed the standard specification of 0.003 inch after the hole in the gear has been ground. The container is open on all four sides between the front and rear chucking units, enabling the chuck to automatically clean itself at all times and preventing the accumulation of grinding solution or emery at any point within the chuck. Ample provision has been made for lubrication of all bearings and for the exclusion of grit.



Duplex Chuck made by the Garrison Machine Works for holding Cluster Gears

KEMPSMITH VERTICAL "MAXIMILLER"

In October, 1918, the Kempsmith Mfg. Co., Milwaukee, Wis., announced to the trade a new milling machine which was designated as a No. 4 horizontal "maximiller." This machine has already become well-known to manufacturers and mechanics, and its favorable reception has led to the development of a No. 4 vertical "maximiller" which is here illustrated and described. In developing this new milling machine, it was not found necessary to make other than minor changes in the table, knee, feed, and traverse mechanisms etc., and as a result the following description will be chiefly confined to those modifications which were involved in the design of the original horizontal machine to produce a vertical miller.

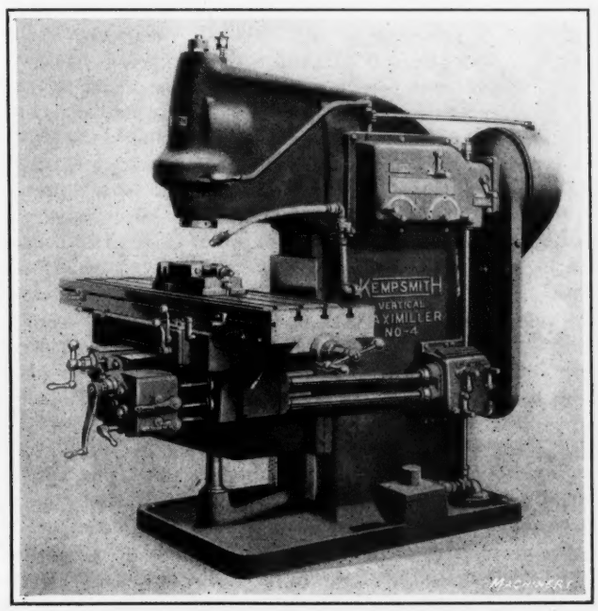


Fig. 1. No. 4 Vertical "Maximiller" built by the Kempsmith Mfg. Co.

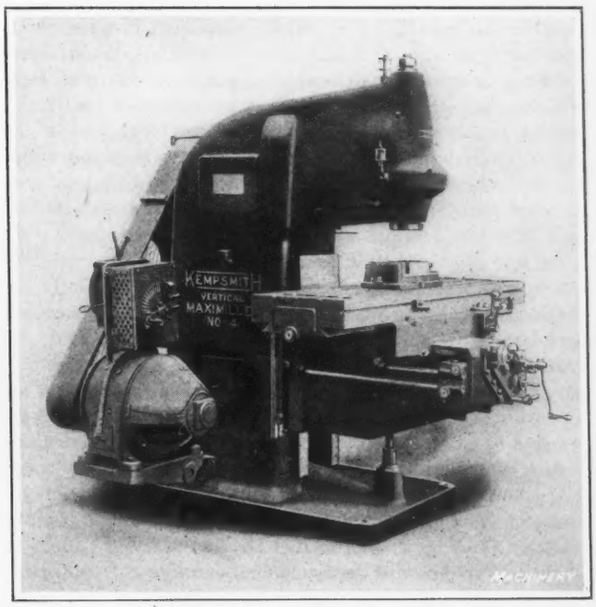


Fig. 2. Opposite Side of the Kempsmith "Maximiller" Showing the Driving Motor

The No. 4 vertical "maximiller" is intended for handling work that requires a heavy, powerful machine constructed along lines that will adapt it for rapid operation and the attainment of accuracy in the finished product. Great care has been taken in working out details of the design to provide for the saving of both time and labor in the performance of milling operations. The main frame members, including the column, knee, saddle, and table are made of semi-steel, and the metal has been carefully distributed to provide ample strength and rigidity at all points, without unnecessary weight. Attention is called to the design of the column, which has very few openings, and these of small size. This fact, in conjunction with ribbing of the column, affords ample strength to avoid springing under the heaviest cuts.

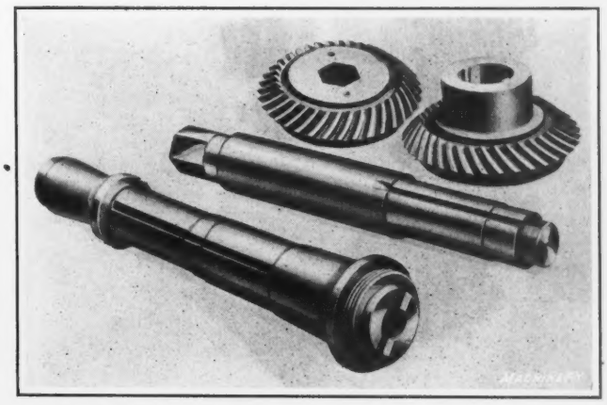


Fig. 3. Spindle, Gears and Driving Shaft of the Kempsmith "Maximiller"

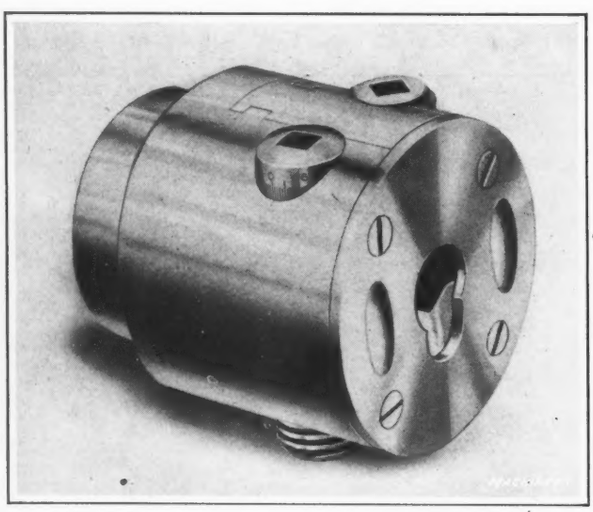
The table has a working surface 70 by 18 inches, in size, with a maximum longitudinal movement of 42 inches. By counterweighting the knee, table, and saddle, with weights placed inside the column, provision is made for securing an easy vertical adjustment of the work in relation to the

cutter, making it unnecessary to have an auxiliary vertical slide for the spindle. The spindle nose is of the Kempsmith patented type, and it is hardened to give ample durability. Provision is made for driving face milling cutters in either direction, and the design of the spindle is such that it also permits the cutter to be quickly and easily removed. The spindle is made of alloy steel, and runs in phosphor-bronze bearings which are easily adjusted to compensate for wear. All other shafts in the speed transmission run on ball bearings. Eighteen spindle speeds are provided covering a range from 14 to 355 revolutions per minute.

Slow speed shafts in the spindle drive are liberally proportioned and made of heat-treated alloy steel. The bevel gears are of large size with coarse-pitch teeth, and they are of the spiral-bevel type giving a smooth silent drive. The driving pulley on the machine is 16¾ inches in diameter and it carries a 6-inch double belt. This pulley is usually arranged to run at 400 revolutions per minute. It is mounted on ball bearings and with the clutch is enclosed in a protective housing. When individual motor drive is employed, the motor is mounted on a bracket at the base of the machine as shown in Fig. 2, and belted to the driving pulley. A 15-horsepower motor is recommended running at 1200 revolutions per minute.

CASLER DRILL CHUCK BORING HEAD

The Marvin & Casler Co., Canastota, N. Y., is now making a tool known as the No. 112 Casler drill chuck boring head, which has been designed to meet the requirements of plants that have use for a Style A boring head of this company's manufacture, but which does not need all of the features that are furnished on it. The drill chuck boring head is equipped with two screws, one for gripping the drill or boring tool, and the other graduated to 0.001 inch, which controls the offset. Drills, reamers, or counterbores with shanks up to ¾ inch in diameter may be chucked. An offset of ⅜ inch can be obtained with either round or hexagonal boring tools up to 9/16 inch in diameter, while an offset of ½ inch is obtainable with round or hexagonal boring tools up to ¼ inch in diameter. This boring head can be equipped with

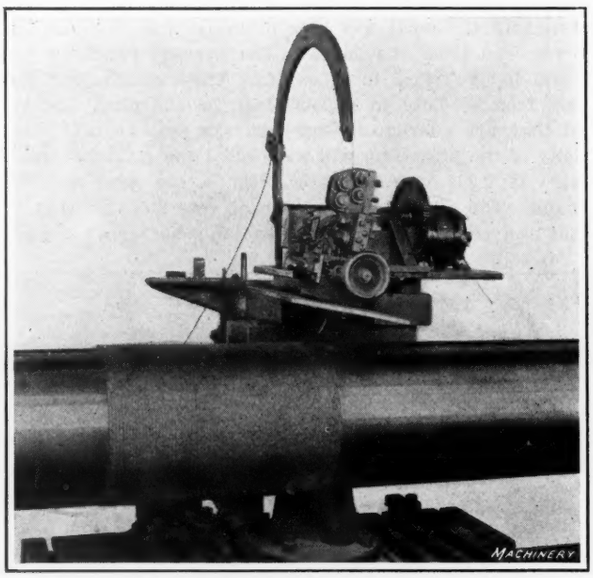


Casler Drill Chuck Boring Head made by the Marvin & Casler Co.

a taper shank and mounted on a milling machine to provide for drilling, reaming, and boring holes in jig, fixture and gage work. It is said to be exceptionally convenient for under-cutting and recessing when used in a turret lathe.

GENERAL ELECTRIC AUTOMATIC ARC WELDER

Automatic arc welding is now accomplished by a new device perfected by the General Electric Co., Schenectady, N. Y., and soon to be put on the market, which is known as the automatic arc welder. It is for use with the regular welding set and is designed to take the place of the hand-controlled electrode. This welder consists of a pair of feed-rollers, driven by a small steady supply of wire, which automatically maintain the best working distance. The whole apparatus is controlled from a small panel. The welding head is held by a suitable support with a certain amount of



A 14-inch Shaft with the Fit increased ⅜ inch in Diameter by the Automatic Arc Welder built by the General Electric Co.

hand-regulated adjustment, and consists of a steel body carrying feed-rolls and straightening rolls which are both adjustable for various sizes of wire. The arm is supported on a gear-box, together with the motor. This box contains gears which give three gear ratios, thus extending the range of the device while allowing the motor to operate at its most favorable speed.

The control panel carries an ammeter and voltmeter for the welding circuit, as well as rheostats, a control relay, and the contactors and switches for the feed motor. It is possible to start and stop the equipment from the work by a pendant push-button, but adjustment of the feed conditions must be made from the panel. The adjustment for arc conditions by regulation of the speed of the feed motor, as the arc voltage varies, is taken care of by the panel equipment. The result is a practically steady arc which increases the speed of the welding.

The whole apparatus is mounted on a base which can be bolted to any form of support. Thus a great variety of working conditions can be met, but provision must be made for carrying the arc at uniform speed along the weld. For instance, for straight seams, a lathe or planer bed may be used, and for circular ones, a lathe or boring mill. However, the local conditions will dictate the method to be followed. The device is especially valuable where a large amount of routine welding is to be done, since it is capable of from two to six times the speed possible to skilled operators and gives a uniform weld of improved quality. It is adaptable for welding seams of tanks and plates, rebuilding worn or inaccurately turned shafts (as shown in the illustration), rebuilding worn treads and flanges of wheels, and for many other kinds of work.

BROWN PORTABLE POTENTIOMETER

The Brown Instrument Co., Philadelphia, Pa., has recently developed a precision portable potentiometer to provide for accurately measuring all electromotive forces in pyrometry. While the use of this instrument is not restricted to such measurements, the ease with which it can be operated makes it especially serviceable for checking millivoltmeters and po-

tentiometers and directly determining the E.M.F.'s of thermo-couples. The limit of accuracy in an instrument of this type is determined by the scale length which is often made about 10 inches. If a 10-inch scale is calibrated to 50 millivolts, one millivolt space will have a length of about 1/5 inch. The scale of the Brown potentiometer is 8 feet or 96 inches in length, and with a range up to 50 millivolts each space indicating a millivolt is nearly 2 inches in length and is graduated to 1/50 of a millivolt. A cadmium sulphate cell having an unsaturated solution, a negligible temperature coefficient, and conforming with the recommendations and specifications of the Bureau of Standards is supplied. These cells are aged for many months before being used. A No. 705 "Ever Ready" dry cell furnishes current for the main circuit and can be bought at any electrical supply store.

Portable Potentiometer made by the Brown Instrument Co., for Use in accurately measuring Electromotive Forces in Pyrometry

Nearly all portable potentiometers have a drum wire of low resistance, measuring about 20 ohms, requiring a comparatively large current and producing a rapid falling off of the dry cell current due to polarization, and also resulting in the dry cell current being unsteady if used for any length of time. The Brown potentiometer has a drum wire of 150 ohms resistance, and the total instrument resistance for 50 millivolts is approximately 4000 ohms, which includes the rheostats. This is gradually reduced to a minimum of 3400 ohms, when the dry cell is exhausted and must be renewed. More than 0.00036 ampere is never required to operate this instrument. An extremely sensitive double-pivoted galvanometer is used, responding to the most minute current. Standard instruments are calibrated from 0 to 25, 0 to 50, 0 to 75 and 0 to 100 millivolts. Special ranges can be supplied up to one volt, if required. Instruments can be calibrated with two scales, equivalent temperature and millivolt scales or equivalent fahrenheit and centigrade scales, if so desired. The Brown precision portable potentiometer can be automatically compensated for the cold junction temperature of one particular type of thermo-couple, provided compensating leads are brought to the instrument.

CUTLER-HAMMER DIRECT-CURRENT MOTOR STARTERS

Although safety is the primary cause of the demand for enclosed starters, some installations require the enclosed type as a means of keeping the contact-making parts clean and the starter in good operating condition. Of the latest additions to the line of enclosed starters manufactured by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., one shown in Fig. 1, consists of the familiar type of direct-current faceplate starter enclosed in a sheet metal case having an external lever which engages the movable arm of the starter. The external, or operating lever is insulated from the revolving contact arm by a block of molded insulation. A pointer on the lever and legends stamped on the cover indicate to the workman whether the starter is "off" or "on." In the smallest size of starter, a knob of black insulating composition is provided in place of the operating lever. A low-voltage release coil in series with the shunt field protects the motor in case of voltage failure or if the field should be opened while the motor is running. The armature resistor is completely enclosed in the starter case, which is kept well ventilated by a flue in the top. Both the enclosed and open type of starters are used with direct-current motors up to 50 horsepower, operating at 115, 230, and 500 volts.

Fig. 2 shows an automatic motor starter panel of the counter E.M.F. type completely enclosed in a cast-iron case with a hinged cover. The automatic feature is obtained by an accelerating contactor which closes when the motor attains about three-fourths full speed, and automatically shunts out the starting resistor. A magnetic main line contactor mounted on the panel allows remote control from two push-button switches of the momentary contact type. The operation of the contactors in conjunction with the push-button switches is as follows: Pressing the "run" button closes the magnetic main line switch, thereby starting the motor with the armature resistor in circuit. The motor accelerates until it reaches about three-fourths normal speed, when the resistor is automatically cut out of circuit by the closing of the accelerating contactor, the operating coil of which is connected across the motor leads and is energized by the counter E.M.F. of the armature. The motor is stopped by pressing the "stop" button, or by voltage failure, both of which cause the main line contactor to drop out. A common snap switch, a float switch or a pressure regulator can also be used for the remote control of the motor. When remote control is not desired the magnetic main line contactor is omitted, and the motor is started by a fused knife switch mounted on the panel with an operating handle outside of the case. The handle can be locked in the open position to prevent unauthorized operation. Interlocks prevent lifting the cover while the switch is closed or throwing the switch with the cover opened. When the knife switch is used, low-voltage release is inherent in the accelerating contactor,

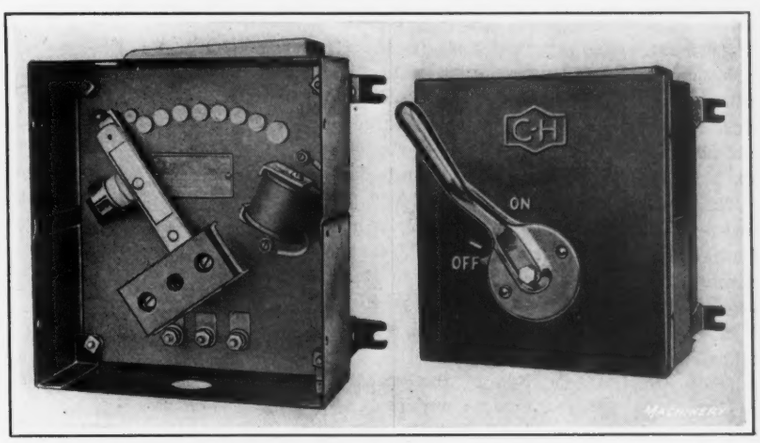


Fig. 1. Faceplate Enclosed Starter made by the Cutler-Hammer Mfg. Co. for Small Direct-current Motors

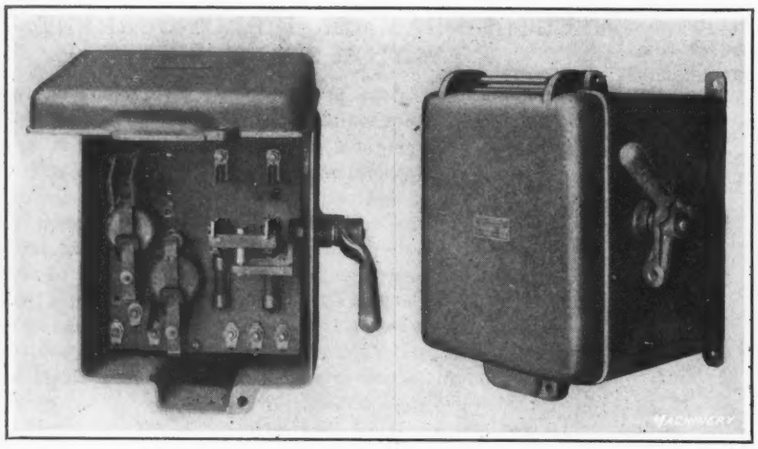


Fig. 2. Automatic Starter made by the Cutler-Hammer Mfg. Co., which can be operated by the External Lever or Push-buttons

which will again close after the voltage returns and the motor has accelerated to three-fourths normal speed, provided the knife switch is still in the closed position. The cast-iron enclosing case is arranged for conduit wiring and can be mounted on a wall or any flat surface. This starter is for use with small direct-current motors not rated over 2 horsepower at 115 volts, or 3 horsepower at 230 volts.

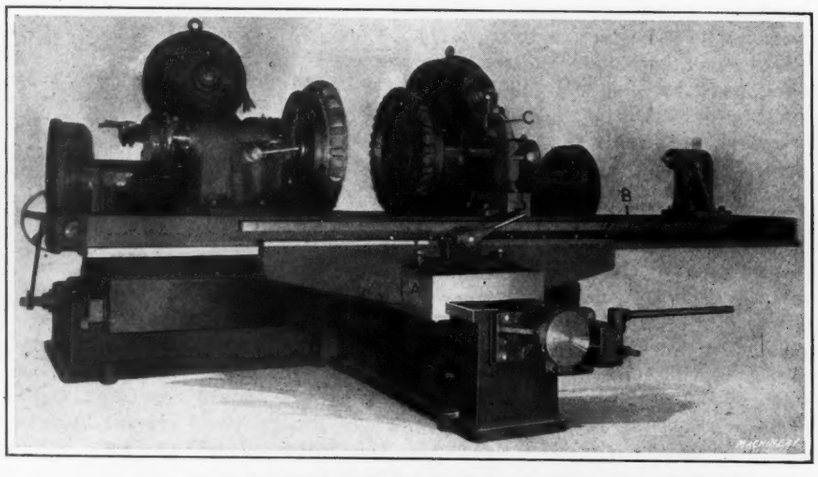
CRANKSHAFT-CHEEK MILLING MACHINE

Machining the outside surfaces of the cheeks of crankshafts on an ordinary lathe is usually an expensive operation, due to the fact that no cutting is done during a considerable portion of the time in which the crankshaft revolves in the lathe. In order to eliminate this non-productive operating time and expense, the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., have recently developed a crankshaft-cheek milling machine, which is here illustrated and described.

This machine has a work-table *A*, 72 inches long and 32 inches wide, on which is fitted the crankshaft holding fixture *B*, the top slide of which is adjustable crosswise through a rack and hand-operated pinion. This table has forward as well as reverse fast power traverse in addition to hand adjustment. The movement of the table is controlled by a revolving screw and a stationary nut. The table is provided with six changes of geared feed obtained through sliding sleeves on which the gears are mounted, and which are enclosed in an oil-tight box. These sleeves are controlled by latch levers conveniently located outside the cover.

The main table has a traverse of 30 inches and hand adjustment along the base. Each cutter-head is 40 inches in diameter over the cutting tools, and each cutter-head saddle has independent hand adjustment on its wing to permit the heads to be adjusted and operated within 4 inches of each other or up to a maximum distance between centers of 30 inches. On the top slide of the crankshaft-holding fixture there is mounted a pair of centers for holding the crankshaft; the center on the right-hand side of the machine occupies a fixed position, and that on the left-hand side is provided with hand adjustment to permit its insertion into the center of the crankshaft. Both center stands are adjustable upon the top slide, the maximum distance between centers being 15 feet. The distance from the centers on which the crankshaft is mounted to the top of the slide is 11 inches. Suitable hand-operated arch clamps *C* are provided for clamping the cranks in place while they are being machined.

Each cutter-head is made from a steel casting, containing slots for the tools which are machined from the solid. The teeth which mesh with the driving gear at the rear of the head are also cut from the solid. The width of each wing on which the spindle saddles are mounted is 56 inches, and the actual length of each spindle saddle bearing on the wing is 50 inches. The height of each wing above the floor is 18 inches, and the height of the main base on which the main table is supported is 28 inches. The cutter-heads are driven by individual motors through internal gears, the latter being fully enclosed. The table is driven by a motor mounted at the back of the machine, which is of the interlocking type, and is so arranged that in stopping the machine this motor will come to a stop before the motors driving the cutter-heads cease to rotate. When starting up the machine, the motors which drive the cutter-heads will start first, thus preventing the breakage of tools or roughing the finished surfaces of the work.



Crankshaft-cheek Milling Machine built by the Newton Machine Tool Works, Inc.

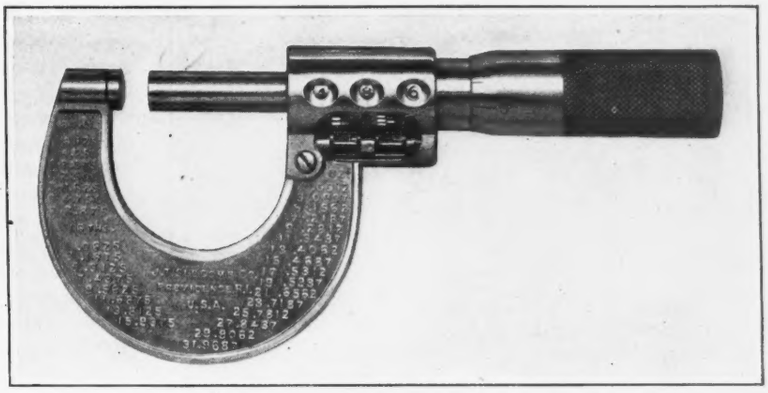
DAVENPORT-SLOCOMB DIRECT-READING MICROMETER

The J. T. Slocomb Co., Providence, R. I., has recently placed on the market a micrometer equipped with a counting device which permits direct reading on every thousandth, from 0 to 0.999 inch. It is claimed that this is the first micrometer caliper to be equipped with such a device, and that in the addition of this new feature none of the well-known Slocomb wear-resisting qualities have been sacrificed. The accompanying illustration of the micrometer, with a portion of the mechanism housing cut away, shows the method of mounting the counting wheels and pinions. It will be seen that the pinions are mounted on an eccentric barrel, which is provided with a clamp screw. This allows the pinions to be thrown into mesh in the same way as the back-gears of a lathe, and, of course, permits of a fine adjustment for mesh. The counting wheels are 0.425 inch in diameter and are mounted on a sleeve that runs concentric with the spindle. A keyway and key in the spindle provide means of driving this sleeve, allowing the spindle a traverse of 1 inch.

It will be noted that this device adds but little to the size and weight of the instrument, and as it is located centrally the micrometer balances well, so that it may be readily held and operated by one hand in the usual way. The frame is a steel drop-forging produced by cold hydraulic pressing in finished steel dies, the same as that of the frame of the regular No. 26 micrometer of this company's manufacture. A pressure of 300 tons is used, which compresses the steel

and adds greatly to its stiffness. This feature assists the workmen to maintain a more uniform "feel" in measuring, as the thimble will come to a dead stop more abruptly. The comparative lightness of this type of frame also makes it more convenient to use.

As previously stated, the reading is direct on every thousandth, and for measurements to an accuracy of 0.0005 inch it is only necessary to see that the right-hand figure is about central in its aperture. Where greater refinement is required, it is necessary to refer to the nearest graduation on the thimble and note how it corresponds with the revolution line on the sleeve, but in any case no calculation whatever is required, and as the pitch of the screw is finer than that employed on the regular type its magnifying power is considerably greater.



Davenport-Slocomb Direct-reading Micrometer made by the J. T. Slocomb Co.

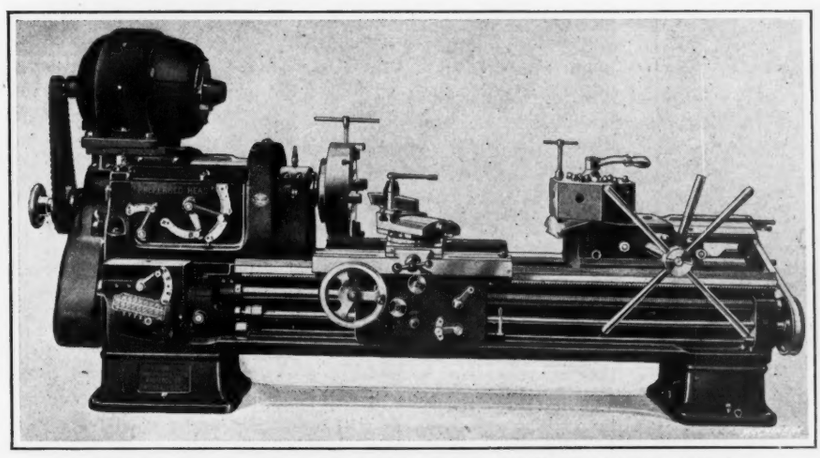
K. R. WILSON TOOLS FOR FORD REPAIR SHOPS

K. R. Wilson, 10-16 Lock St., Buffalo, N. Y., has recently placed on the market a line of tools especially designed to meet the requirements of garages specializing in the work of repairing Ford automobiles. Recent additions to this line of garage equipments include a valve seater and facer, a propeller shaft reamer with a guide, a propeller shaft bearing end-mill, a combination end-mill and arbor for facing spindle body bushings and worn axle forgings, and a spiral reamer and jig for cast-iron camshaft bearings. This line of tools includes a total of fourteen different equipments and others are in course of development.

CINCINNATI GEARED-HEAD LATHES

The lathe shown in the accompanying illustration represents one of the latest types of patented geared-head lathes built by the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. This lathe is now made in 16-, 18-, 20-, 22-, 24-, 26-, and 28-inch sizes and may be either single-pulley belt-driven, or motor-driven. It may also be obtained with the regular type of tailstock in place of the turret. Equipped with the hexagon turret as shown, and with power feed and silent chain drive, this lathe is said to be particularly well adapted for general manufacturing purposes.

Twelve mechanical speed changes in geometric progression are secured through sliding gears by simply manipulating the three levers marked *CD*, *AB*, and 1 2 3. A neutral position is also obtainable, which permits the spindle to be easily revolved by hand. By referring to a simple easily read index-plate, the operator can quickly determine the proper position of change-gear levers for any desired speed within the wide range of spindle speeds obtainable on this lathe.



One of the Recent Types of Geared-head Lathes built by the Cincinnati Lathe & Tool Co.

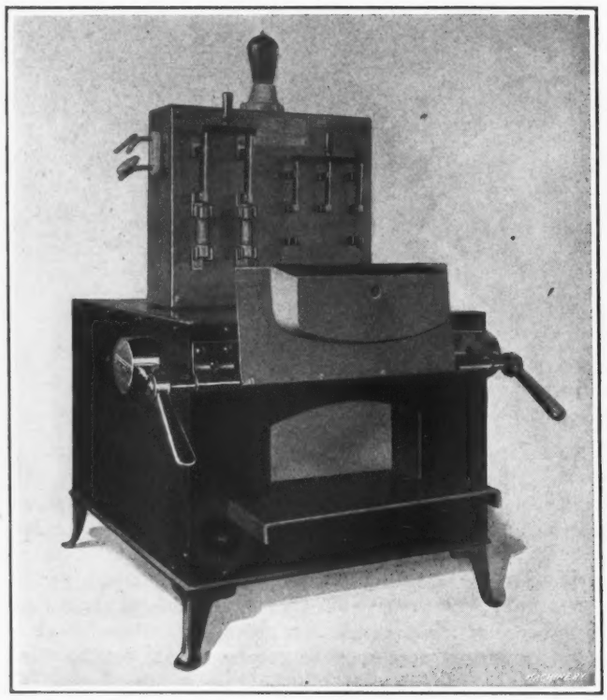
No safety device is necessary, as the levers and gearing are so arranged that the gears cannot be made to lock while operating, and any lever may be shifted without interfering with the others. At the apron there is a control lever by which the spindle may be stopped, started or reversed without stopping the motor, or the driving pulley.

The range of feeds and threads obtainable is almost unlimited, and a convenient index-plate is furnished to show how any desired feed may be obtained. All bearings and gears are oiled automatically by the splash system, oil being properly distributed by the gears to grooves provided in the top cover. An indicator shows at all times the amount of oil in the base of the head. The design of these lathes is similar in many respects to the cone type of lathes manufactured by this company for the past fifteen years.

GENERAL ELECTRIC MUFFLE FURNACE

The General Electric Co., Schenectady, N. Y., has developed an electric furnace of the muffle type, which is designed to meet the demand for a durable, economical and convenient furnace for temperatures up to 850 degrees C., (1530 degrees F.), for baking vitreous enamel, hardening and tempering tools, dies, etc. This device consists of the furnace proper with a control panel mounted above it. The furnace is very strongly built, but small enough to be placed anywhere that will prove convenient. A heating element, which is mounted on the outside of the muffle and covered with compound, is so placed as to give a very even distribution of heat throughout the inside. This element is divided so that it is possible to get two degrees of heat, for convenience called "low" and "high" heat. The former is used to give a high initial heat so that the maximum temperature can be reached quickly—in an hour and three quarters to be exact—and the latter is sufficient to maintain this temperature. The muffle is mounted in a strong steel casing, and the walls, door, etc., are thoroughly insulated, thus preventing loss of heat from radiation.

The control panel, which carries the necessary apparatus for controlling the furnace, is equipped with a main line switch, a double-throw switch for high or low heat, and a red pilot lamp which acts as a warning to the operator when the furnace is on high heat. There are connections at the side of the panel for connecting rheostats when temperatures as low as 300 degrees C. are desired. By this arrangement, a very good control of the temperature is assured, and, due to the pilot lamp, there is very little excuse for the destruction of material due to carelessness, or inability on the part of the operator to tell what heat is on, The furnace is further provided with a shelf in front for the convenience of the



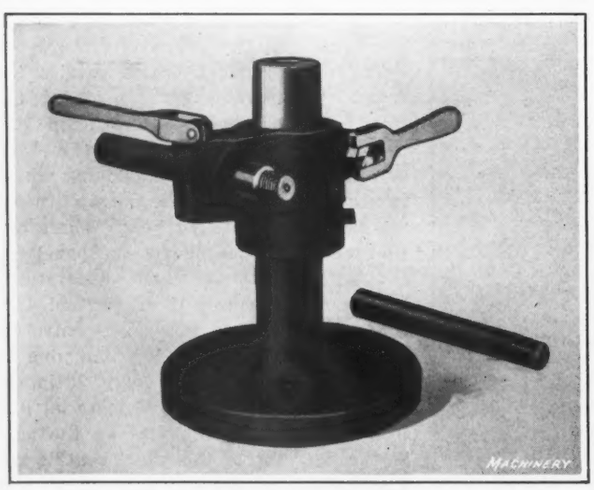
Electrically Heated Muffle Furnace made by the General Electric Co. Temperatures up to 1530 Degrees F. are Available

operator, and the door is equipped with counterweights to keep it open. The high heat necessitates 4 kilowatts to bring it up to 850 degrees C.

The advantages claimed for the use of this furnace for laboratory or shop service are manifold. Fumes, noise, and smoke that accompany the use of some furnaces are absent. The fire risk of the furnace is said to be practically non-existent. It is perfectly safe to go away and leave it alone for any length of time, on low heat, and the pilot lamp serves as a warning so that the high heat will not be left on. This furnace does not occupy a great deal of space, and can be set in the most convenient place for operation, without disturbing any of the rest of the installation. It is adaptable to numerous applications, such as heating carbon steel in tool making, baking patterns on china, and laboratory work of all sorts.

"THOR" UNIVERSAL REPAIR VISE FOR PNEUMATIC DRILLS

For use in tool-rooms and machine shops which are called upon to handle repair work on pneumatic drills, the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., has recently developed the "Thor" assembling and repair vise which is suitable for holding all makes of pneumatic drills. It provides for firmly clamping and holding the drill in various accessible positions while the necessary repairs, assembling, and testing are done. It will be seen that the vise consists of a flanged upright stand, a sliding collar to quickly adjust the vise to the proper height for convenient working, a set-screw for holding the collar in place, and a clamp that swivels on the collar and is securely held in any position by tightening a screw. At the other end of the clamp there is a hole which receives a threaded stem on which the drill is screwed. For small sized drills a stem support or adapter is used to enable a stem of proper size to be utilized.



"Thor" Universal Repair Vise for Pneumatic Drills made by the Independent Pneumatic Tool Co.

COLUMBIA HEAVY-DUTY SHAPERS

In the accompanying illustrations there are shown two views of a heavy-duty crank shaper which is built in 16-, 20-, 24-, and 28-inch sizes by the Columbia Machine Tool Co., Hamilton, Ohio. These machines have a friction clutch and brake, adapting them for either single-pulley or constant-speed motor drive. Four changes of speed are provided by the speed-box and this number is doubled by the back-gears, giving a total of eight rates of speed. The friction clutch and brake enable the shaper to be quickly started or stopped at any point of the stroke. Changes of feed are furnished by the gear-box that provides eight variations on the 16- and 20-inch shapers and twelve changes on the 24- and 28-inch machines. A small handle, which is conveniently located

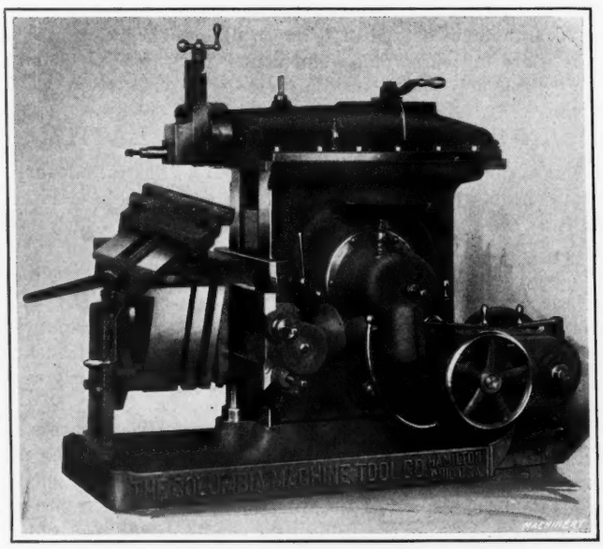


Fig. 1. Heavy-duty Crank Shaper built by the Columbia Machine Tool Co.

for the operator, provides for obtaining either of the available rates of feed, and changes can be made while the machine is running. The arrangement is such that feeding only takes place on the return stroke and the mechanism automatically adjusts itself to the position of the cross-rail. A small lever is provided just behind the cross-rail, which controls and indicates the direction of feed; and this lever can also be operated without stopping the machine. A safety friction guards against damaging the mechanism, and the feed-gears are made of steel and hardened, these gears operating in a bath of oil.

An important feature of these shapers is the revolving table, which is of exceptionally rigid construction. The table is carried on a hub or trunnion bolted to the saddle of the machine, and in addition an outer support is provided, this arrangement being an adaptation of the standard table support used on other machines of this company's manufacture. The arrangement will be readily understood from Fig. 1. The base extends beyond the outer end of the table and is of the so-called "pan" construction, with the top fully en-

closed, thus preventing oil from dropping on the floor. This enclosed top, supplemented by a heavy flange and ribs, assures a rigid foundation for the machine. The column is of box section and is made flush at the front without overhang and allowing ample traverse of the ram with the head set at an angle.

Extending the ram guides at the rear affords a long bearing surface, and the ways for the cross-rail are V-shaped, the rail being gibbed and locked on the operating side by one lever. A ram of girder construction is employed, and the head has vertical feed with micrometer adjustment and can also be set at any desired angle. The use of a collar

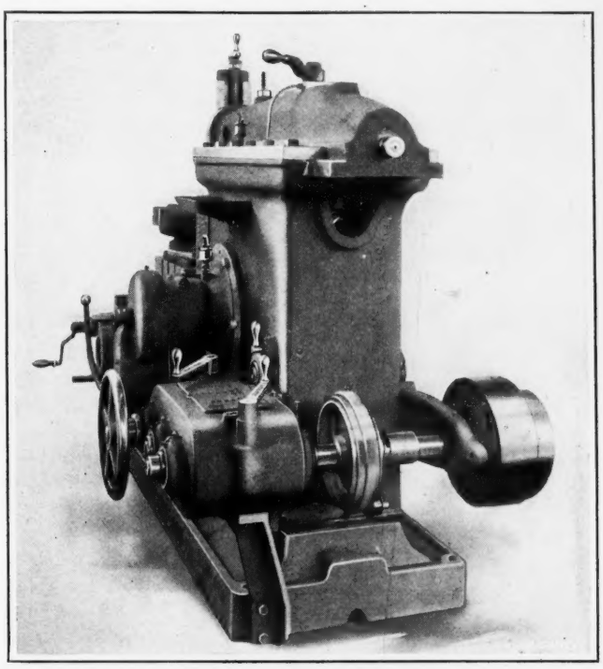


Fig. 2. Rear View of the Columbia Heavy-duty Crank Shaper

graduated in degrees facilitates the making of such settings. A powerful friction clutch and brake placed between the driving pulley or motor and the speed-box is operated by the curved handle at the side of the column, which is easily reached by the operator and provides for quickly stopping or starting the machine at any point of its stroke, a feature that is especially valuable in tool-room work.

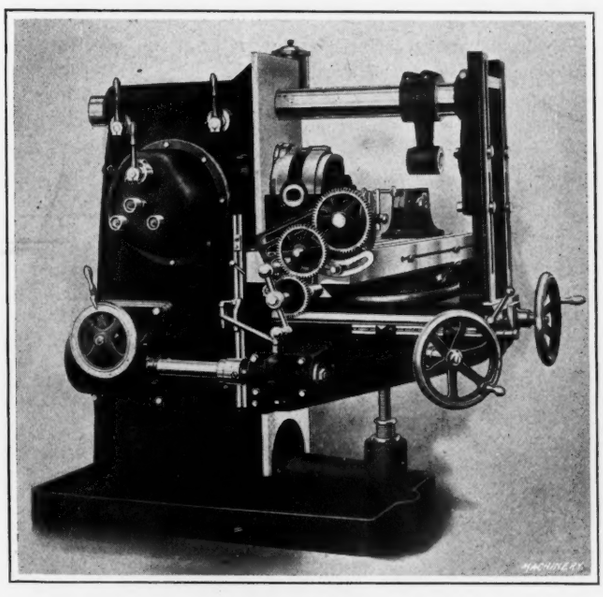


Fig. 1. No. 3 Milling Machine built in Plain and Universal Types by the Conradson Machine Tool Co. and sold by Joseph T. Ryerson & Son

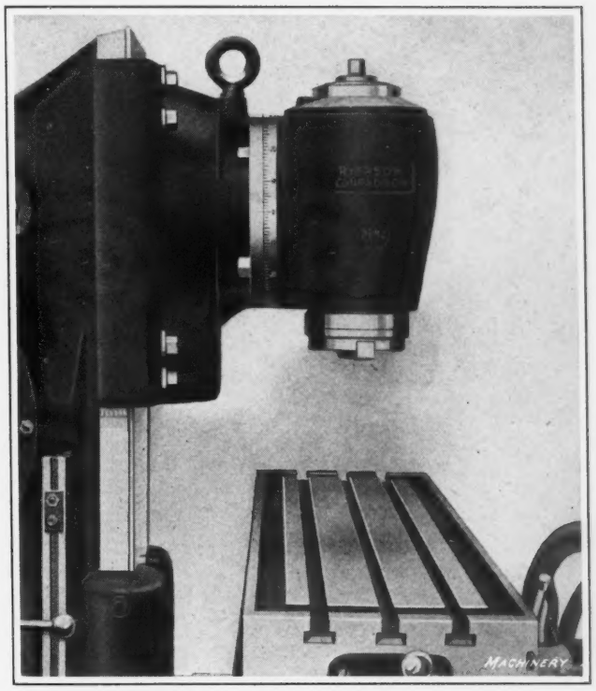


Fig. 2. Vertical Attachment for the Ryerson-Conradson Milling Machine

RYERSON-CONRADSON MILLING MACHINE

In the March, 1917, number of MACHINERY a description was published of a No. 3 plain milling machine with single-pulley drive, which had just been developed at that time by C. M. Conradson, Eau Claire, Wis. The most noteworthy feature of the design of this machine was the arrangement

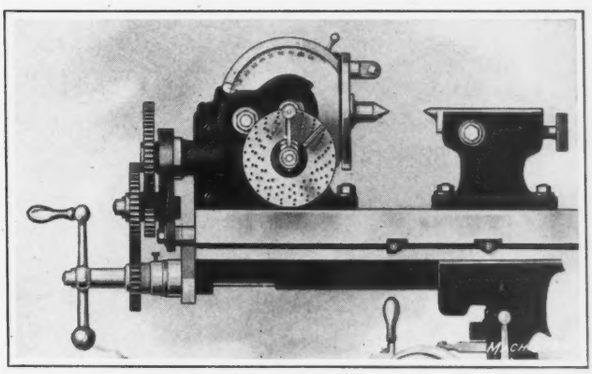
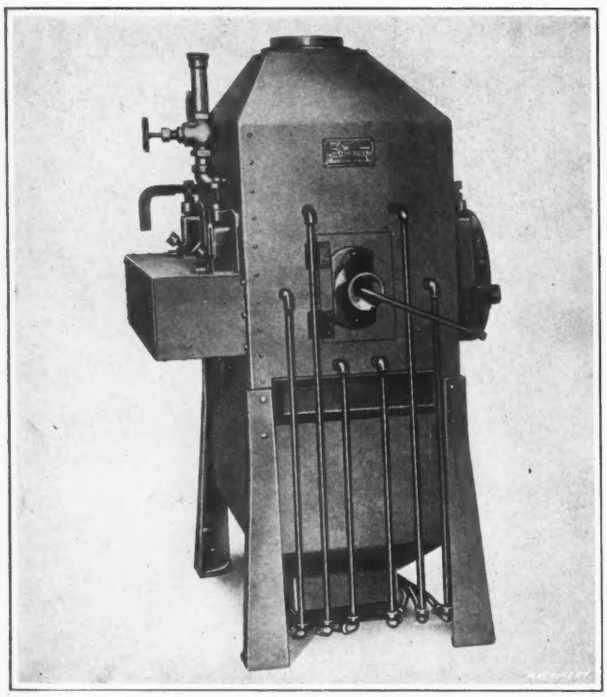


Fig. 3. Universal Dividing Head for the Ryerson-Conradson Milling Machine

of an oscillating speed-box, having sliding change-gears to transmit power through either a spiral pinion to a spiral gear keyed to the milling machine spindle, or through a worm to a worm-wheel mounted on the spindle. This machine is now being built in plain and universal types by the Conradson Machine Tool Co., Green Bay, Wis., and Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill., are sales agents, the machine being one of a line of machine tools to be known as Ryerson-Conradson machines.

PANGBORN ROD-CLEANING SAND-BLASTING CABINET

A new cabinet for sand-blasting various shaped rods, from ⅜ to ⅞ inch in diameter, just produced by the Pangborn Corporation, Hagerstown, Md., embodies the features of continuous operation and a hygienic construction for the protection of the operator. The blasting operation being entirely confined, the cabinet can be readily installed with other machine tools without detriment; and this feature



Rod-cleaning Sand-blasting Cabinet built by the Pangborn Corporation

also removes the operator from all contact with the dust laden air. A set of rolls and guides at either end of the cabinet provides constant, uniform travel of the rods through the blasting zone. The feed-rolls are shaped to handle all diameters from ⅜ to ⅞ inch and of varying shapes.

By six blast projectors, centering to the rod at a 45-degree angle, the blast stream covers the entire surface of the rod, the discharge being directed toward or into a small chamber that utilizes the rebound effectiveness of the abrasive. Scale has been removed from ¾ inch diameter rods, with 80 pounds air pressure, at the rate of fifty lineal feet per minute. The bottom of the cabinet forms a hopper for abrasive storage. The blast action is of the suction type, and individual feed-boxes, in plain sight of the operator, feed each blast projector. Connection to an exhaust system removes disintegrated material. The cabinet is adaptable for use with either sand or the metal abrasives and occupies a floor space of but 45 by 51 inches and is 69 inches high.

COLD-SAW CUTTING-OFF MACHINE

A recent development in cold-saw cutting-off machines for cutting large ingots and heavy forgings, known as the U-96 machine, has been recently brought out by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. This saw is equipped with an inserted-tooth saw blade 76 inches in diameter which has a capacity for cutting stock 24 inches in diameter in one cut. The saw blade (which is not shown in the illustration) is held in place by the flanges *A* on the saw arbor.

A main work-table *B*, 56 inches long in the direction of the feed of the saw and 48 inches wide, is bolted to the machine base. To this table is bolted a platen *C*, 60 inches long, 56 inches wide, and 12 inches deep, which is provided with suitable T-slots. On this platen there is a clamping block *D* which is 18 inches wide at the base and 12 inches wide at the top. The top of this block is in line with the top of the main table *B*. Two V-blocks are fitted to the main work-table and one V-block is fitted to the block *D* as shown.

A swivel arch clamp is supplied for each of the V-blocks and the clamps are so arranged that they will hold work 32 inches in diameter. The drive of the machine is from a belt-connected motor through a solid bronze worm-wheel and hardened steel worm fitted with roller thrust bearings. Both the worm-wheel and the worm are encased and run in an oil bath. A pinion cut in the solid steel shaft of the worm-wheel transmits power to the spindle driving gear. The feed motion is obtained from the driving shaft through gearing to an oil-tight feed-box in which the change-gears are mounted on a sliding sleeve controlled by latched levers in the cover. From this box the motion is transmitted to the saddle feed-screw through a feed-worm and worm-wheel which is positively clutched.

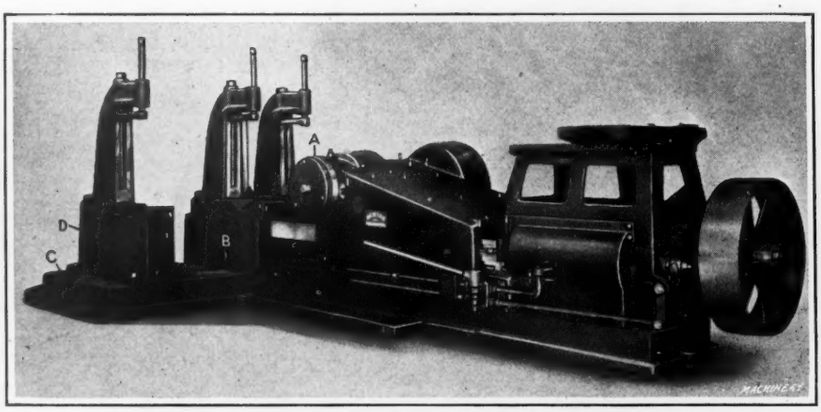
The machine is controlled from the rear; and forward feed with automatic stop, and rapid traverse forward and back with automatic stop are also provided. The feed and rapid traverse mechanism is enclosed with curtain covers, and a positive safety release is provided for each extreme position of traverse. The oil and chip pan is cast on the base, thus permitting the lubricant to drain back into the reservoir. A loose chip pan is fitted between the tables which conducts the oil to the pan on the base.

GABRIELSON MILLING MACHINE

The Gabrielson Mfg. Corporation, 318 First Trust and Deposit Co., Bldg., Syracuse, N. Y., has developed the manufacturing milling machine that is shown in the accompanying illustrations. In designing the Gabrielson miller the object kept in view was a machine that would do comparatively heavy-duty milling and still maintain accuracy of size and finish. Attention is called to the very small number of parts, a feature which makes for strength and rigidity. The machine shown in this article is known as the 6-inch machine because six inches is the maximum distance between arbor and table.

At a glance it will be seen that this miller differs quite noticeably from the conventional design. The frame casting, including the section that supports the table and also the section supporting the arbor, is made in one piece and very heavy so as to absorb the strains of cutting and to afford ample support for the spindle, arbor and table. Inasmuch as the table is mounted in the main casting, no vertical or lateral adjustment is possible, and the cutter movement with relation to the work is secured by moving the entire spindle with its bearings and arbor support. Not only is this true of its vertical adjustment but provision is also made for moving the arbor in or out of the machine to obtain lateral adjustments of the cut.

The main frame casting is mounted on a sub-base, the bottom section of which is used as an oil supply tank for the cutting lubricant. Power is received from the main driving pulley at the back of the machine and thence up to the spindle through gearing. As this machine is intended for manufacturing operations and is usually kept on the same



Cold-saw Cutting-off Machine built by the Newton Machine Tool Works, Inc.

class of milling, the feeds and speeds are seldom changed. Therefore, the machine is furnished with but one pair of feed gears which provide two changes of feed. However, extra feed gears may be ordered, so that any desired speeds and feeds may be selected, varying with the class of work to be done.

From the sectional view of the machine, Fig. 2, the construction of the spindle, spindle carrier and adjacent mechanism may be studied. The spindle is made of tool steel and hardened and ground. It is mounted in straight bearings, the outer parts of which are tapered, and fitting-in sleeves may therefore be closed in to take up wear and permit adjustment. The spindle and its bearings are eccentrically mounted in the large diameter spindle carrier, and by turning this carrier, the spindle and cutter are raised or lowered with relation to the table. This method of adjustment is a feature of the Gabrielson milling machine. The total vertical travel of the spindle is one inch and this travel is used only for the final movement of the cutter. The work is mounted approximately to the right height by means of the fixtures on the table, and this one-inch vertical movement is for the final cutter adjustment.

In making this vertical cutter adjustment, the tumbler gear that connects the gearing with the spindle driving gear is dropped down out of mesh by releasing a lever that may be seen at the front of the machine, beneath the spindle carrier. Then the spindle carrier locking bolt is loosened as well as the arbor support lock. After this it is only necessary to turn the handle at the front end of the spindle, and the desired vertical travel of the spindle and arbor is secured through a worm and worm-wheel. During this operation the arbor support travels with the arbor, and at the end of the adjusting operation the arbor support and spindle carrier are locked, the tumbler gear is thrown in mesh, and the machine is ready to run. Graduations on the end of the spindle carrier make exact adjusting easily performed.

To secure any necessary longitudinal arbor adjustment, the crank at the rear of the spindle mounting is used. By its means a movement of one-half inch is available for adjustments after the approximate location of the cutters on the arbor have been made. The table is very heavy and mounted as it is, directly on the massive frame casting, chattering is practically impossible. The table has a travel of 31 inches and has a working surface 7 by 34. Three T-slots are provided for mounting fixtures, and at the outer edge of the table there is a deep trough to carry away the cutting lubricant. The lubricant runs back to the supply tank in the base of the machine by means of a channel cut through the frame. The table feed is provided with a trip that may be seen at the front, and hand traverse and reverse may be had through the large operating wheel at the front.

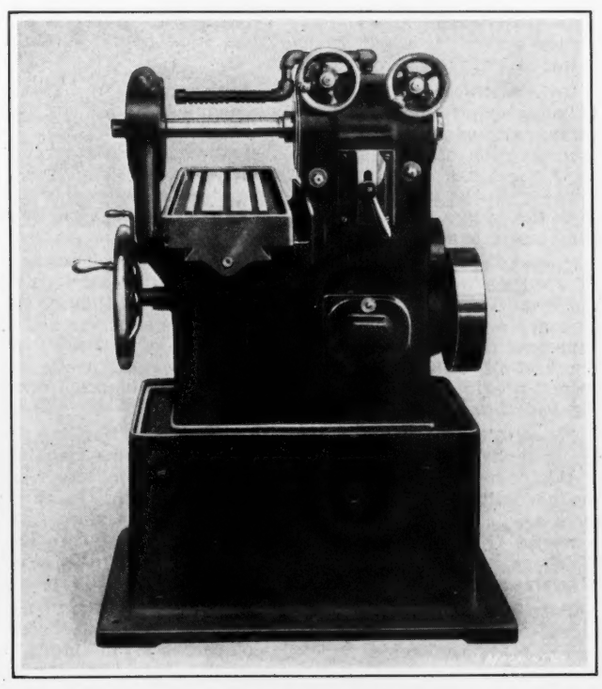


Fig. 1. Manufacturing Miller recently developed by the Gabrielson Mfg. Corporation

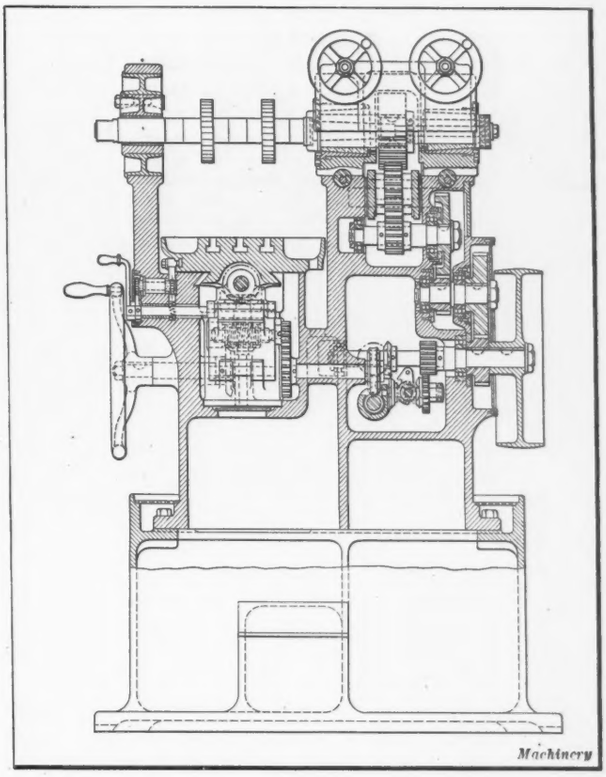


Fig. 2. Cross-sectional View through the Gabrielson Miller showing Arrangement of the Mechanism

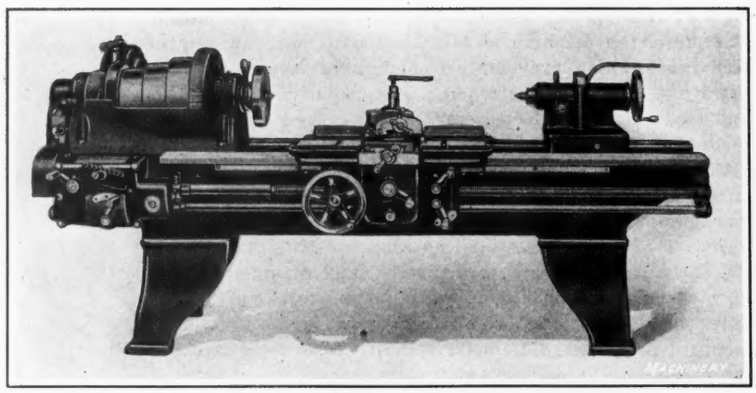
The machine will carry cutters up to 10 inches in diameter and they are mounted on the arbor by removing the arbor support bushing and passing them through the hole at this end of the frame casting. After the cutters are correctly spaced on the arbor and held by the nut, the arbor support bushing is fitted and locked into the frame casting. The machine is arranged so that motor drive may be easily applied.

MORRIS ENGINE LATHES

In the accompanying illustration there is shown an engine lathe with what is known as a semi-enclosed headstock, which is built in 16-, 18- and 22-inch sizes by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. This machine is equipped with a quick-change-feed box that provides forty-five changes of feed; and threads ranging from 2 to 60 per inch, including the 11½ pipe thread, can be cut. The feeds are positive geared and twice the number of threads. When so desired, a semi-quick-change-feed box can be furnished through which four positive changes of feed are instantly obtained. With even gears on the stud and screw these feeds are 8, 16, 22, and 32 cuts per inch, and threads ranging from 2 to 30 per inch, including 11½, can be cut on a machine that is so equipped.

A complete set of change-gears is provided with each box to cut these threads. The quick-change and semi-quick-change boxes are interchangeable, and provision is made for the use of change-gears to cut special pitches or metric threads. A chasing dial is furnished as a standard equipment. For use on these machines an improved type of taper attachment can also be provided, which is said to give very satisfactory service under heavy cuts. This attachment is graduated to express tapers in degrees or in inches per

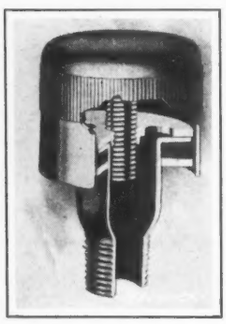
foot. It can be applied to any Morris lathe as all machines are arranged for the use of this auxiliary equipment. Provision is made for handling work up to a maximum taper of 4 inches per foot, and at a single setting of the work the 16- or 18-inch lathes will turn pieces 22 inches long, and the 22-inch lathe will turn pieces 25 inches long.



Engine Lathe built in 16-, 18-, and 22-inch Sizes by the Morris Machine Tool Co.

GARRISON GREASE CUP

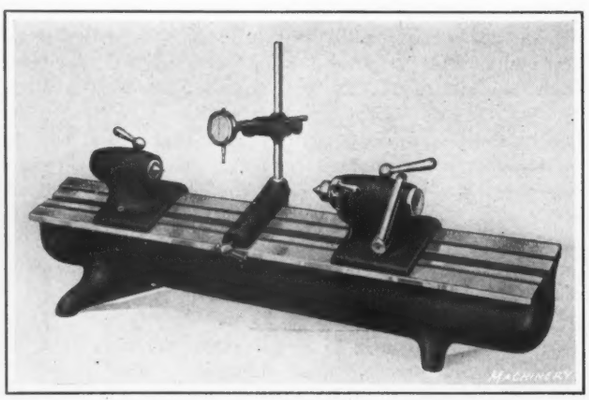
The Garrison Co., 348 George St., Bridgeport, Conn., is now manufacturing what is known as a center-thread grease cup which is made in three different sizes. This cup is adapted for use on any class of machine shop equipment where satisfactory lubrication can be accomplished with grease. Reference to the accompanying illustration will make it apparent that the actuating screw of this grease cup is contained at the center, the screw being attached to the middle of the cover so that it may enter a tapped hole in the top of the cup. In using this grease cup, the grease is placed in the cover around the screw and the cover is then pushed over the top of the body, a leather packing being provided to prevent grease from leaking out of the cup. When the cover is screwed down the grease is forced through three holes, and down through the center feed tube into the bearing. It is claimed that these cups are easy to refill, that there is a positive feed of grease to the bearing, and that there is no danger of crossing or jamming the threads on the cup.



Center-thread Grease Cup manufactured by the Garrison Co.

AMERICAN GAGE CO.'S BENCH CENTERS

The American Gage Co., Dayton, Ohio, has recently developed a set of bench centers shown in the accompanying illustration. The bed is made of box section and rests on three feet to assure a steady support, and the top face of the bed is inclined to prevent this accurately finished surface from constituting a convenient place for laying wrenches and other tools that would be likely to mar the bearing. A fine adjustment is provided for setting the indicator. These bench centers are made in two sizes, namely, 6 by 24 inches and 8 by 36 inches, and they are regularly furnished with an indicator reading to 0.001 inch.



Bench Centers made by the American Gage Co.

* * *

A few minutes spent in properly sharpening drills saves many a broken tool, and much expense for new drills.

NEW MACHINERY AND TOOLS NOTES

Cherrying Attachment: Jackson Machine Tool Co., Jackson, Mich. An attachment for No. 5 and No. 6 Jackson duplex die-sinking machines which adapts them for the performance of cherrying operations. This attachment was developed by redesigning one originally developed for the No. 10 die-sinker of this company's manufacture.

Metal Melter: General Electric Co., Schenectady, N. Y. An electrically operated device for use in melting lead, babbitt, and similar metals. It is designated as a 25-pound electric bench pot and is intended to eliminate the loss of time and material and danger of fire, incident to the melting of metal under some conditions that are quite commonly used.

Shaper: Davis Machine Tool Co., Inc., Rochester, N. Y. Until recently the shaper built by this concern was only made with a gear-box drive, but a model has now been placed on the market which is equipped with a four-step cone pulley and double back-gears, giving eight speeds which are in geometric progression and cover a range from 10 to 115.

Double Toolpost: Connery Machine & Tool Co., 56 Harrison Ave., Springfield, Mass. A device known as the P.M.B. double toolpost which is built of heavy steel and made of simple and durable parts. A broad solid jaw clamps two tools, and an irregular hexagon-headed clamping bolt provides for securing the toolpost to the T-slot in the cross-slide of any lathe.

Direct-reading Cylinder Gage: American Machine Products Co., Marshalltown, Iowa. A cylinder gage adapted for the use of garage mechanics which serves as a substitute for an inside micrometer. While measuring a cylinder bore with this device, it is merely necessary to find one of 9 blades which fits the bore and then read the size that is stamped on that blade.

Universal Joint: R-S Mfg. Co., Kansas City, Mo. In this universal joint there is a flexible member having six lugs arranged to engage a like number of rollers mounted on the inner portion of the case. It is claimed that this arrangement combines the universal action of a ball and socket joint with the anti-friction qualities of a roller bearing. Both the rollers and the curved surfaces of the lugs are hardened and ground.

Hinge Forming Dies: Service Machine Co., Elizabeth, N. J. Dies for use in applying a new method of forming hinge members on sheet metal stamped parts. Dies of this type are applicable in automobile sheet metal shops and in numerous other establishments. Two sets of dies are used, the first of which is an ordinary blanking die while the second provides for the performance of a combination drawing and forming operation on the work.

Cut-off Slide for Screw Machine: Millholland Machine Co., Indianapolis, Ind. A power cut-off slide for screw machines of this company's manufacture. It is intended for use when the necessity arises for facing or forming while the turret tools are in operation. This cut-off slide has a simple and powerful friction drive, and an automatic stop is provided which may be tripped by either of two adjustable dogs. When necessary a hand-trip lever can also be utilized.

Grinding Machine Spindle Construction: Badger Tool Co., Beloit, Wis. A ball-bearing spindle mounting for use on the grinding machines of this company's manufacture, in which one radial bearing is employed in each housing together with an additional double row of ball thrust bearings in the left-hand housing. The bearings are fitted into indi-

vidual housings made detachable from the main body of the machine in order to obtain a high degree of accuracy.

Rolling Mill: Standard Machinery Co., Auburn, R. I. A rolling mill designed for use in producing wire and thin-gage flat metal stock. The steel rolls are hollow, and after hardening they are ground to a smooth surface. Herringbone gears transmit power to the rolls, these gears being enclosed and arranged to run in a bath of oil. A water cooling system circulating through the bodies of the rolls keeps their surfaces cool, even while the machine is running at high speed.

Round Master Blocks: Wilton Tool & Mfg. Co., 84 Linden Park St., Boston, Mass. A series of round master gage-blocks that are put up in sets comprising different combinations. For instance: One set consists of blocks varying from 0.100 to 2.000, the variations being such as to give dimensions by thousandths from 0.400 inch to 8 inches. Other sets give dimensions from 1/16 inch to 1 15/16 inches by intervals of 1/16; from 0.10 to 2.10 by tenths; and from 1 to 41 millimeters by millimeters. It is claimed that these gages are accurate to within 0.000015 inch.

Flexible Shaft: N. A. Strand & Co., 549 W. Washington Blvd., Chicago, Ill. A link-type of flexible shaft which is claimed to be so designed and constructed that wear on the joints is reduced to a minimum. Shafts of this type are made with links 1 inch in diameter, while the diameter over the case is 1½ inches. The standard length of these shafts is 7 feet and they are adapted for a maximum speed of 1750 revolutions per minute. At 400 revolutions per minute, 2-horsepower can be transmitted, and these shafts will drive a grinding wheel up to 10 by 1½ inches in size.

Inverted Drilling Machines: Foote-Burt Co., Cleveland, Ohio. Drilling machines built with inverted spindles in order to assist in clearing the chips from the hole, particularly in the case of deep-hole drilling; to facilitate the drilling of parts which are carried to the machine on a conveyor, and where it is desirable to drill the hole without having to roll over each piece of work; and to avoid difficulties sometimes experienced from breaking drills when the work is unusually tough or difficult to cut for other reasons. Machines in which this principle of design is employed are built in a variety of different styles to handle a number of classes of drilling operations.

Continuous Drilling, Boring, Turning and Facing Machines: Foote-Burt Co., Cleveland, Ohio. On these machines, applications of the so-called "continuous" principle of machining enables the operator to be constantly employed in removing finished pieces from the machine and setting up fresh blanks, while the machine is operating on another piece of work. This reduces idle time of both the machine and its operator, which is a condition of unusual importance at a time when there is an urgent demand for production and when the cost of labor is at an unprecedented level. These new Foote-Burt machines have twelve spindles and they are adapted for a wide range of work. Various machines are built on this principle for performing such operations as drilling, boring, turning, facing, etc.

Plate Bending Rolls: Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. A set of plate bending rolls of unusually large size, which were built by Kling Bros. Engineering Works of Chicago, Ill., and sold by Joseph T. Ryerson & Son of that city to the General American Tank Car Corporation of East Chicago, Ind. This machine is furnished with steel gears having cut teeth, and all bearings are bronze bushed. The machine measures 34 feet 2 inches between the housings, and it has sufficient capacity for bending ¾-inch mild steel plates. The top roll is 29 inches in diameter and weighs about 40 tons, while the bottom roll is 21 inches in diameter. In addition to these rolls there are two other roller supports. A rigid cast-iron sub-base supports the rolls and they have independent motors for the main drive and for power adjustment of the top roll.

* * *

MASS AUTOMOBILE PRODUCTION IN ENGLAND

English automobile manufacturers are planning quantity production, according to the American Chamber of Commerce in London. A $30,000,000 combine in the British motor industry has been effected. As a result of this combine, a new company will be formed which will be known as Harper, Bean, Ltd., and which will include many leading firms in the automobile field as well as a number of subsidiary manufacturers of electric lighting and starting sets, jigs and tools, radiators, and accessories. The amalgamation gives the new company control of the manufacture of all the component parts of automobiles. It is planned to standardize designs, and production will begin immediately at the rate of fifty cars a week increasing to 300 a week in July, 1920, to 600 in December, and rising ultimately to 2000 a week in 1923.

NON-TECHNICAL INTERESTS OF ENGINEERS

A debatable question no longer exists as to whether engineers of the country should get together in furtherance of their non-technical interests. The attitude everywhere is not whether, but how shall this end be achieved? Some engineers evidently think that a sort of super-organization of the founder societies should be brought into existence, or perhaps a federation of all societies, but an increasing number are coming to the conclusion that the end will be best accomplished by using the well-tried machinery at hand, designed for this purpose, namely that of the American Association of Engineers.

A striking omission occurs in the report of the Joint Conference Committee of the older societies, one which by its absence attracts comment throughout the rank and file of the profession, namely the neglect to refer to the fact that the work proposed to be done has already been undertaken and is well advanced by the American Association of Engineers, with a membership now larger than that of any other national society. From all parts of the United States is coming the question "Why has the Joint Conference Committee's report been silent on this vital question?"

In answer to this question and in the firm belief that the rank and file of the profession are waiting for such an announcement, the secretary of the American Association of Engineers on December 20, 1919, addressed the following letter to the governing bodies of the founder societies:

> The development of the opinion in the founder societies in favor of giving attention to the non-technical side of the engineer's life has led several members of each to ask the American Association of Engineers to write simultaneously to the governing bodies of these societies offering its service in problems of public and professional welfare and asking their cooperation.
>
> We have read the report of the Joint Conference Committee and believe that the American Association of Engineers, a successful going organization, is capable of carrying forward the non-technical activities recommended in the report fully as well and perhaps better than the organization recommended by the conference report. The activities of the American Association of Engineers are confined to social and economic problems such as legislation, employment, compensation, political and civic endeavor. The association takes in everyone of good character in the engineering profession and seeks to mobilize all engineers for joint action. It gets its support from the man back home without any intermediate representation so that it is able to do the things that lie close home and that make living as an engineer worth while.
>
> If the founder societies elect to cooperate with the American Association of Engineers in the work it is doing and in similar non-technical activities, it would be our understanding that such support would not be financial and would in no way interfere with present prerogatives and privileges of the founder societies.
>
> C. E. DRAYER
> Secretary, American Association of Engineers, Chicago, Ill.

* * *

GUARANTEES AGAINST DECLINE IN PRICES

The Federal Trade Commission has announced that the question of guarantee against decline in price has been the subject of so many complaints before the commission, and opinions seem to be so diverse, that the commission has determined to go into the whole matter thoroughly. Therefore, producers, manufacturers, merchants, dealers, and consumers are invited to state their opinion in writing to the commission. Later, it is the purpose to call a general hearing at Washington, at which interested people may be present in person or be represented by counsel. Letters have been sent out to various associations and manufacturing concerns, inviting cooperation in determining the policy to pursue in regard to the question of guarantee against price decline.

* * *

A booklet has been published by the National Civil Service Reform League, 8 W. 40th St., New York City, containing recommendations for improvements in the foreign service of the United States, with a view to providing the commerce and industry of the nation with adequate assistance on the part of the Government in establishing and maintaining trade relations on a basis which will make it possible to compete successsfully with other nations in the foreign markets. In order to gain this end, it is proposed to require definite standards for eligibility to our consular and diplomatic services and to make the consular service such that the business interests may be adequately served by it.

Terms Used in Export Trade

Owing to the confusion that often arises due to misinterpretation of the terms and abbreviations used in export trade, and the consequent trade disagreements, a conference of leading national trade organizations recently was held in New York City, at which definitions of export terms were adopted and general recommendations made for a standard American export practice. The associations participating in the adoption of these definitions and standards are: the National Foreign Trade Council, the Chamber of Commerce of the United States of America, the National Association of Manufacturers, the American Manufacturers' Export Association, the Philadelphia Commercial Museum, the American Exporters' and Importers' Association, the Chamber of Commerce of the State of New York, the New York Produce Exchange, and the New York Merchants' Association.

THE leading national trade organizations recommended as the most certain means of insuring that no mistakes be made in terms and conditions of sale, that manufacturers and exporters abandon the use of all abbreviated forms in export price quotations and write out the terms in full. It is believed, however, that this recommendation is not likely to be accepted generally at once, and, therefore, in the hope of effecting a simplification of standards of American practice, it has been decided by these national trade organizations to adopt certain definitions of the abbreviated forms in more general use in the export trade.

It is understood that unless a particular railroad or other transportation facility is specified, the shipper will deliver the goods to be sold at the carrier most conveniently located to him. If the buyer desires the goods to be delivered to a carrier further removed from the shipper and entailing a greater cost than delivery to the carrier most favorably situated, the carrier to which the buyer desires delivery of the goods, should be named in the quotation.

There are, ordinarily, ten different conditions upon which the sales contract may be based. Each of these will be taken up in detail and the terms involved under each heading, explained. The following five abbreviations are those most commonly used in export quotations:

F. O. B.....Free on board
F. A. S.....Free alongside ship
C. & F.....Cost and freight
C. I. F.....Cost, insurance and freight
L. C. L.....Less than carload lot

F. O. B. (Named Point)

This term is used when the price quoted applies only at inland shipping point and the seller merely undertakes to load the goods on or in cars or lighters furnished by the railroad company serving the industry, or most conveniently located to the industry, without other designations as to routing.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; and (3) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) pay all transportation charges including taxes, if any; and (3) handle all subsequent movement of the goods.

F. O. B. (Named Point) Freight Prepaid to (Named Point) on the Seaboard

This term is used when the seller quotes a price including transportation charges to the port of exportation without assuming responsibility for the goods after obtaining a clean bill of lading at point of origin.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; (3) pay freight to named port; and (4) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad company.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) unload goods from cars; (4) transport goods to vessels; (5) pay all demurrage or storage charges; and (6) arrange for storage in warehouse or on wharf where necessary.

F. O. B. (Named Point) Freight Allowed to (Named Point) on the Seaboard

This term is used where the seller wishes to quote a price, from which the buyer may deduct the cost of transportation to a given point on the seaboard, without the seller's assuming responsibility for the goods after obtaining a clean bill of lading at point of origin.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; and (3) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad company.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) pay all transportation charges (buyer is then entitled to deduct from the amount of the invoice the freight paid from primary point to named port); (3) handle all subsequent movement of the goods; (4) unload goods from cars; (5) transport goods to vessel; (6) pay all demurrage or storage charges; and (7) arrange for storage in warehouse or on wharf where necessary.

F. O. B. Cars (Named Point) on Seaboard

This term is used when the seller desires to quote a price covering the transportation of the goods to seaboard, assuming responsibility for loss or damage up to that point.

Under this quotation the seller must (1) place goods on or in cars; (2) secure railroad bill of lading; (3) pay all freight charges from forwarding point to port on seaboard; and (4) be responsible for loss or damage until goods have arrived in or on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) unload goods from cars; (3) handle all subsequent movement of the goods; (4) transport goods to vessel; (5) pay all demurrage or storage charges; and (6) arrange for storage in warehouse or on wharf where necessary.

F. O. B. Cars (Named Port) L. C. L.

This term is used when the goods, on which a price is quoted covering the transportation of the goods to the seaboard, constitute less than a carload lot.

Under this quotation the seller must (1) deliver goods to the initial carrier; (2) secure railroad bill of lading; (3) pay all freight charges from forwarding point to port on seaboard; and (4) be responsible for loss or damage until goods have arrived on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) accept goods from the carrier; (4) transport goods to vessel; (5) pay all storage charges; and (6) arrange for storage in warehouse or on wharf, if necessary.

F. O. B. Cars (Named Port) Lighterage Free

This term is used when the seller quotes a price which will include the expense of transportation of the goods by rail to the seaboard, including lighterage.

Under this quotation the seller must (1) place goods on or in cars; (2) secure railroad bill of lading; (3) pay all transportation charges to, including lighterage at, the port named; and (4) be responsible for loss or damage until goods have arrived on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) take out the insurance necessary to the safety of the goods after arrival on the cars; (4) pay the cost of hoisting goods into vessel where weight of goods is too great for ship's tackle; and (5) pay all demurrage and other charges, except lighterage charges.

F. O. B. Vessel (Named Port)

This term is used when the seller desires to quote a price covering all expenses up to and including delivery of the goods upon the overseas vessel at a named port.

Under this quotation the seller must (1) meet all charges incurred in placing goods actually on board the vessel; and (2) be responsible for all loss or damage until goods have been placed on board the vessel.

The buyer must (1) be responsible for loss or damage thereafter; and (2) handle all subsequent movement of the goods.

F. A. S. Vessel (Named Port)

This term is used when the seller desires to quote a price covering delivery of the goods alongside overseas vessel and within reach of its loading tackle.

Under this quotation the seller must (1) transport goods to seaboard; (2) store goods in warehouse or on wharf if necessary, unless buyer's obligation includes provision of shipping facilities; (3) place goods alongside vessel either in a lighter or on the wharf; and (4) be responsible for loss or damage until goods have been delivered alongside the ship or on wharf.

The buyer must (1) be responsible for loss or damage thereafter, and for insurance; (2) handle all subsequent movement of the goods; and (3) pay cost of hoisting goods into vessel where weight of goods is too great for ship's tackle.

C. & F. (Named Foreign Port)

This term is used when the seller is ready to go further than the delivery of his goods upon the overseas vessel and is willing to pay transportation to a foreign point of delivery.

Under this quotation the seller must (1) make freight contract and pay transportation charges sufficient to carry goods to agreed destination; (2) deliver to buyer or his agent proper bills of lading to the agreed destination; and (3) be responsible for loss or damage until goods have been delivered alongside the ship and clean ocean bill of lading obtained (seller is not responsible for delivery of goods at destination).

The buyer must (1) be responsible for loss or damage thereafter and must take out all necessary insurance; (2) handle all subsequent movement of the goods; (3) take delivery and pay costs of discharge, lighterage and landing at foreign port of destination in accordance with bill of lading clauses; and (4) pay foreign customs duties and wharfage charges, if any.

C. I. F. (Named Foreign Port)

This term is used when the seller desires to quote a price covering the cost of the goods, the marine insurance on the goods, and all transportation charges to the foreign point of delivery.

Under this quotation the seller must (1) make freight contract and pay freight charges sufficient to carry goods to agreed destination; (2) take out and pay for necessary marine insurance; (3) be responsible for loss or damage until goods have been delivered alongside the ship, and clean ocean bill of lading and insurance policy have been delivered to the buyer, or his agent. (Seller is not responsible for the delivery of goods at destination, nor for payment by the underwriters of insurance claims); and (4) provide war risk insurance, where necessary for buyer's account.

The buyer must (1) be responsible for loss or damage thereafter, and must make all claims to which he may be entitled under the insurance directly on the underwriters; (2) take delivery and pay costs of discharge, lighterage and landing at foreign port of destination in accordance with bill of lading clauses; and (3) pay foreign customs duties and wharfage charges, if any.

The National Foreign Trade Council, India House, Hanover Square, New York City, will furnish exporters any further information on this subject upon application.

* * *

POWER TRANSMISSION BY STEEL BELTS

Thin flat steel belts are now being extensively used in England for power transmission purposes, with results, it is claimed, which go to prove that such belts can transmit much more power for the same width than those made of other materials, and that they are not affected to any appreciable extent by temperature changes, or changes in the humidity of the air, which adapts them for use in damp places, as there is little stretching or slipping. It is claimed that power for power the weight is about one-sixth that of leather or rubber belts. The thickness of steel belts varies from 0.2 to 0.9 millimeter and the width from 12 to 200 millimeters.

The material used is a carefully hardened charcoal steel, rough-rolled at a red heat, and then brought up to final size by cold working. The tensile strength of the finished material is about 95 tons to the square inch. The edges are rounded and finely finished, thus enabling the belt to be safely handled. The elasticity remains unimpaired with use, and speeds as high as 10,000 feet per minute are possible. From the foregoing facts it is evident that power transmission by steel belts is a matter for serious consideration, and some discussion regarding its application should prove of interest.

The belts are supplied by Steel Belts, Ltd., Falkland Works, Manchester, England, and during a period of over six years they have fitted a large number of installations throughout the country, in works where steadiness and uniformity in running are essential. They are also being extensively applied in rolling mills and cement works, where great variation in load is encountered. The conditions under which steel belts can be satisfactorily applied are more exacting than those required by rope or leather belt drives, but it is said that a considerable gain in efficiency results. Shafts, bearings and pulleys for steel belts must be of solid construction. The shafts must be parallel and the pulleys must run true. With steel belt transmission, it is necessary that the pulley face be flat; this is owing to the fact that if the pulley were crowned, the center of gravity of the joint clip would be slightly raised from the pulley every time the clip ran on the latter, thus causing an impact, which would become greater as the belt speed is increased or the diameter of the pulley reduced. The stress caused by this blow would be thrown mainly on the middle of the belt, and this would cause gradual deterioration of the material at this point and ultimate fracture. As power for power the steel belt is only one-third the width of an equivalent leather belt, the use of specially designed narrow and correspondingly stronger pulleys enables considerable saving in weight to be made, particularly in the case of large diameters. The material is practically static, the limits of contraction and expansion being only 1/32 inch to the yard, so that the tension for any particular power or width can be exactly determined. Thus, when the belt is properly mounted it should require no further attention.

A typical steel belt drive installed in a large cotton spinning mill near Halifax consists in part of an engine drum, which is an ordinary grooved, rope-driving drum, 16 feet in diameter, adapted at one side for steel belt power transmission. A casing carries the belts to the belt-race, at a center distance of 96 feet. Two belts are employed, each 8 inches in width. These two belts transmit 500 horsepower. The driven pulley is 4 feet 5¼ inches in diameter and makes 300 revolutions per minute. From the driven shaft power is transmitted to four floors by perpendicular drives also employing steel belts.

Adapting Rope-driving Pulleys for Steel Belts

Converting from rope drive to steel belt drive is a comparatively simple matter. The rope-driving pulleys are converted by shrinking a steel band round the pulley rim, which is done in the following manner: A section is cut out across the top of the grooves in the pulley into which a joint plate is placed. The steel band is then prepared, being cut short by an amount suitable to give the requisite tension when jointed. A number of screw holes are drilled and countersunk in each end to correspond with similar tapped holes in the joint plate. Two tapping holes are also drilled at a short distance from each end of the belt, for the purpose of attaching a turnbuckle cramp to draw the ends together round the pulley. The band is placed in position, the cramp attached ready to draw the ends together, which is done after first slightly heating the band below the cramp at each end, using a Bunsen flame for this purpose. The band can then be easily drawn together, owing to expansion taking place, thus allowing the screws to be inserted. Contraction ensues on cooling off, and the pulley is tightly gripped. The cramp is removed, and the heads of the screws and the joint soldered over, thus giving a continuous band.

Steel belts can be run metal-to-metal or on a smooth surface, but after a time there is a tendency to polish the pulley; therefore it is found desirable, in order to prevent any possible slip, to give the pulley rim a friction coating. This is done by cementing a canvas band on the outer face of which thin sheets of cork are glued. To avoid stripping this covering under variable load, the face of the pulley is first prepared with a series of serrations made by a rough file or chisel.

Fitting and Jointing the Belt

The steel belt is now ready to be fitted. Its length is determined by means of a special calibrating instrument. A light steel tape is placed over the pulleys and subjected to a predetermined tension, the overlaps of the ends of the measuring bands are then cut off, the tension being released, and the remaining length is the correct measurement to which the unstrained driving belt must be cut.

A special form of joint is provided which insures durability at that point. It consists of a top and bottom clamping plate curved to suit the pulley profile. The top plate has extension surfaces of suitable curvature, from which the metal belt may ride off on transition from the straight path to the circular path around the pulley; the bottom plate is composed of two short, thin, wedge-shaped pieces. The belt is placed over the pulleys, drawn together by cramps and V-headed screws inserted through suitably prepared holes in the plates and the belt. The screws are, after insertion, soldered over on the heads and riveted on the inside and filed smooth, the drive being thus completed. It is said that the whole conversion of a complete rope drive to a steel belt drive, such as the one described, can be carried out between a Saturday noon and starting time on Monday morning.

The Life of Steel Belts

Steel driving belts have now been in operation for over six years, and tests made of the belts first fitted show no signs of deterioration. It seems evident, therefore, that the life of the steel belt is long. In calculating and constructing metal belt gearing, consideration is given to the fact that the metal belt to be employed is subjected to a flexure constantly varying from zero to a maximum, that is, from the straight path to the greatest amount of curvature when passing over the pulleys. To insure durability with such a demand, it is not sufficient for the belts to be calculated in the usual manner—that is, so that the greatest bending stress which occurs is below the limit of fracture of the material. As a result of extensive researches it is claimed that a fracture of the belt can be avoided, if the varying demand upon its flexibility is kept so low that the maximum demand does not attain half the value of the limit of fracture.

The Efficiency of Steel Belts

An efficiency in power delivery of 99 to 99½ per cent is claimed for steel belts. A steel belt does not stretch by use, as has been proved by six years' experience; and as there is no measurable slip, it naturally follows that the transmission is uniform. These features make the belts particularly suitable for perpendicular drives. The distance of the centers is optional to a great extent, depending on the speed. Where space is cramped and the drives run to various floors, steel belts can often be used to advantage. In cases where the pulleys are limited in size it is often possible to obtain an increase in power transmitted by the substitution of steel belts, without any further rearrangement.

With ordinary care steel belts are safe, as in case of fracture the belts will not fly but fall between the shafts. As the edges are rounded they may be handled while running. It is only in isolated cases that fracture occurs, and this is invariably due to a flaw in the material, which will show itself, should it exist, within the first eight weeks of running; after that time it is a practical certainty that the belt is free from flaw.

* * *

RAILWAY CAR AXLE DESIGN

In the article on the design of railway car axles, in the February number of MACHINERY, it is stated on page 499 that an axle 4¼ by 8 inches, having a load capacity of 22,000 pounds is required. According to the dimensions given in the table, this axle has a section modulus of 16.3. However, the 4¼ by 8-inch axle with a load capacity of 18,000 pounds would be sufficient, this axle, according to the dimensions given, having a section modulus of 12.25. The reason why this latter axle would be sufficient in this case is that the wheel diameter in the problem is only 26 inches, whereas the axle having a capacity of 22,000 pounds is suitable for a wheel 33 inches in diameter. Therefore, while the load is 20,000 pounds, the strain on the axle is lessened by reducing the size of the wheel and thereby the lever arms, so that the strain would not be as great as for a 33-inch wheel.

* * *

The Interstate Commerce Commission reports that the increases in freight and passenger rates during federal control up to July 31, 1919, amounted to $1,835,000,000, while the increases in wages to the employes amounted to $1,774,800,000 during the same period. In other words, 97 per cent of the revenue from the increased rates went to paying increases in wages. The British Railway Administration has announced that new freight rates are to be put into force, showing increases of from 25 to 100 per cent on present charges. These increases are made necessary by the increases in wages granted to the British railway employes.

* * *

The headquarters for the Rhodes scholarship in the United States from now on will be at the Massachusetts Institute of Technology, Cambridge, Mass. Professor Aydelotte of that institution, duly appointed secretary to the Rhodes scholars throughout the United States, will devote all his efforts during the present academic year to the selection of men from the American universities who are to be sent to Oxford College.

PROPOSED MERGER OF THE SOCIETIES FOR STEEL TREATING

If the recommendations contained in a report of the joint committee from the American Steel Treaters Society and the Steel Treating Research Society, become effective, these two organizations will be merged and known as the American Society for Steel Treating. It is proposed to incorporate the organization under the state laws of Ohio, and to establish headquarters in Cleveland. Briefly stated, the object of the new society will be to promote the arts and sciences connected with the treatment of iron and steel. The amalgamation committee which has recommended the proposed merger is headed by Lieutenant-Colonel A. E. White, professor of chemical engineering, University of Michigan. The remaining personnel of the committee is composed of three members of each of the two merging societies.

* * *

GOVERNMENT NEEDS DRAFTSMEN

The United States Civil Service Commission announces that the Government is in need of a large number of draftsmen. It is stated that fully 1000 draftsmen were appointed in the Government service during the last calendar year. During this period of reconstruction technical men are especially needed. Besides draftsmen, there are openings for surveyors and computers, as well as assistant and associate engineers—electrical, mechanical, civil, chemical and ceramic. Further information and application blanks may be obtained from the secretary of the United States Civil Service Board at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle, and San Francisco, or from the United States Civil Service Commission, Washington, D. C.

* * *

MOTION PICTURES AS AN AID IN SELLING MACHINERY

The Merchants & Manufacturers Exchange of New York has provided a motion picture theater on the tenth floor of the Grand Central Palace for the use of the exhibitors in the permanent international exposition of industries which is housed in the building. After having shown to buyers the machine exhibited on one of the floors of the palace, the exhibitor may ask his visitors to the motion picture theater for a demonstration of the machine in action in a factory. It is expected that the use of motion pictures will be helpful to exhibitors, as the value of motion pictures, especially in the selling of heavy machinery, is well recognized. The industrial applications of the motion pictures are becoming more numerous every day, as their value is being realized.

* * *

MATERIAL HANDLING MACHINERY MANUFACTURERS ASSOCIATION

On page 556 of the February number of MACHINERY it was mentioned that the Material Handling Machinery Manufacturers Association held its annual meeting January 29 and 30. As a matter of fact, the meeting held on those dates was only a meeting of the executive committee and the board of governors of the association, while the annual convention was held February 26 and 27 at the Waldorf-Astoria Hotel, New York City.

* * *

MORSE CHAIN CO. ON PROFIT-SHARING PLAN

The Morse Chain Co., Ithaca, N. Y., has inaugurated a profit-sharing plan according to which the company will pay in October of each year to every worker who has been in the company's employ one year or more, a dividend on his wages, averaged as if the wages had been invested in the company's business and at the same rate as drawn by the stockholders on the company's investment. In addition, the company proposes to establish what is known as a service store where all employes may purchase goods at cost.

PERSONALS

R. L. WILSON, formerly general superintendent of the East Pittsburg works of the Westinghouse Electric & Mfg. Co., has been made works manager.

A. A. SIAMIESKI has been appointed assistant general manager of the Jackson Screw Products Co., Inc., Jackson, Mich., to take the place of V. L. Curren.

E. G. MIDDLETON has been appointed advertising manager of the Colburn Machine Tool Co., Franklin, Pa., manufacturer of vertical boring mills and heavy-duty drilling machines.

E. R. NORRIS has been appointed director of works equipment of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., in charge of machinery, tools, and methods in the various plants.

J. D. APGAR, formerly of the Machine Tool Engineering Co., of New York City, has joined the sales force of the Van Norman Machine Tool Co., Springfield, Mass., as a direct representative in the New York office, 320 Fifth Ave.

A. A. ROELOFS, formerly special representative in the Ohio territory, of the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., manufacturer of the multi-graduated precision grinder, has been made manager of the Chicago office.

DEAN B. COBB has started a drafting and blueprinting business at 265 Main St., West Haven, Conn. Mr. Cobb would like to have his name placed on the mailing lists of manufacturers who are interested in the electrical and mechanical field.

ALEXANDER TAYLOR, for many years manager of works of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been made assistant to the vice-president in general charge of production, stocks, and stores in all the Westinghouse plants.

W. V. HOUCK, formerly factory manager of the Buffalo Metal Goods Co., Buffalo, N. Y.—a subsidiary plant of the General Motors Corporation—has become vice-president and general manager of the O'Neil Iron Works, Inc., 268 Perry St., Buffalo, N. Y.

JOHN E. HUBBELL, counsellor at law and solicitor of patents, formerly located at Chambers and Hubbell Sts., Philadelphia, Pa., has opened offices at 469 Fifth Ave., New York City, where his practice will be devoted to patent and trademark matters exclusively.

WILLIAM R. GUMMERE, who represented the Independent Pneumatic Tool Co. for a number of years in Cleveland, Ohio, has again become affiliated with the company and is now connected with the Pittsburg branch, which is under the management of Harry F. Finney.

C. J. STILWELL, foreign sales manager of the Warner & Swasey Co., Cleveland, Ohio, sailed for Europe, January 21, with the intention of visiting England, France, Belgium, Holland and other countries in the interest of the company. Mr. Stilwell will be gone about three months.

J. G. MILES has been appointed supply division manager of the Seattle office of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., succeeding C. V. Aspinwall who is now located at Spokane, Wash. Mr. Miles has been associated with the supply department of the company for many years.

F. RODGER IMHOFF, New England representative of the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., has recently been made field engineer. He will make his headquarters in Detroit, Mich., and will cover the entire country in the interest of the multi-graduated precision grinder.

E. R. WOOD, formerly with the selling organization of Sherritt & Stoer, Philadelphia, Pa., has joined the sales force of Alfred Herbert, Ltd., 54 Dey St., New York City, and will represent that company in the New York district in the sale of imported and domestic machine tools and supplies.

C. D. PORTERFIELD, who formerly represented the Colonial Steel Co. in the New York territory, has recently joined the sales force of Alfred Herbert, Ltd., 54 Dey St., New York City, and will handle the steel and small tool lines of the company in the metropolitan district and in New York State.

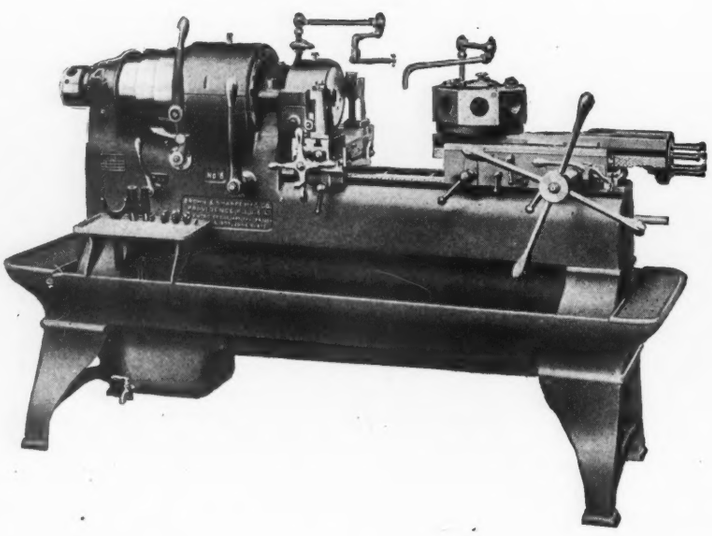
ROBERT G. PILKINGTON has been appointed experimental engineer by the Wahl Co., Chicago, Ill. His duties will consist of the consideration of the methods, materials, and designs to be used in connection with the adding machines, "Eversharp" pencil, and fountain pen made by this company.

B. C. SAUNDERS, who was recently sales manager of the Wilmarth & Morman Co., Grand Rapids, Mich., has purchased an interest in the Grand Rapids Grinding Machine Co. and become associated in the active management of the business. At the last annual meeting he was elected secretary and sales manager.

—the small helps make

Put those small, quick set-up jobs on a reduced time basis—jobs too small to warrant much set-up time, yet requiring rapidity and accuracy in production. The time- and labor-saving features, the real production boosters, are the winning points that speak for

Brown & Sharpe
Wire Feed Screw Machines



We cover a range that is adequate to meet the broad demands of the shop. There are five different sizes from which you can select—our Catalog 22G shows the entire line and describes the many details of construction that interest the manufacturer.

Brown & Sharpe
Providence,

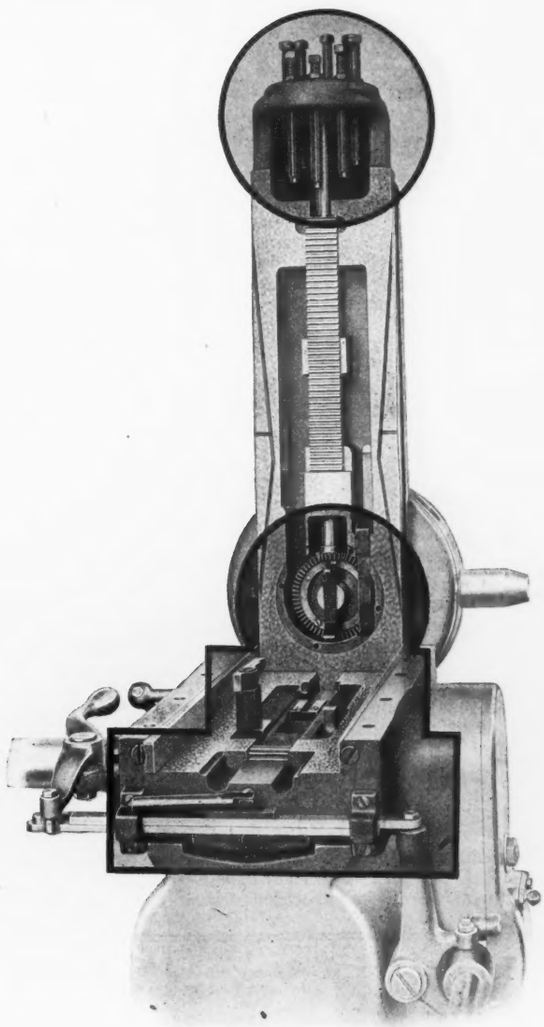
the big savings

Turret Slide Features

The disc shown in circle carrying individual stop screws—one for each turret position, obviates setting each tool exactly. In addition to a positive lock by means of a taper pin which aligns the turret holes with the spindle, the larger machines are automatically clamped as the turret is moved forward by a tapered bushing which is controlled by the rocker arm shown in the centre of the large bevel gear.

The transverse and vertical adjustment for alignment is by means of the adjustable taper gibs shown in cut.

Combine these many small helps and labor-saving features with the rugged construction and practical design and the reason for Brown & Sharpe preference is evidenced.



Mfg. Co.

R. I., U. S. A.

CHARLES EISLER has become associated with the Newark Engineering & Tool Co., Newark, N. J., as consulting engineer and vice-president. Mr. Eisler's specialty is incandescent lamp-making machinery, and he was for many years connected with the Westinghouse Lamp Co. He recently completed a lamp factory for the Save Electric Corporation.

GEORGE W. CHILDS has started a consulting engineering business at 701 Crozer Bldg., Chester, Pa. The field covered by Mr. Childs will include power transmission; rolling mill, cotton mill, and dredging machinery; machine tools; tools, jigs and fixtures; foundry and sand-blast equipment; ship construction; seacoast and artillery material; and the development of inventions.

R. A. DEMEILLERS, formerly chief tool designer with the New Process Specialty Co., Milwaukee, Wis., has become associated with the Gould & Eberhardt Co., Newark, N. J. in the capacity of tool supervisor of all the Gould & Eberhardt plants. Previous to his connection with the New Process Specialty Co., Mr. Demeillers was chief tool engineer of the Wallis Tractor Co., Racine, Wis.

FRANK L. WALTER, for the last eight years head of the designing department and master mechanic of the Dayton Engineering Laboratories Co., and for six years previous in the National Cash Register Co.'s tool designing department, has entered into business at 520-530 Lindsay Bldg., Dayton, Ohio, under the name of Walter Engineering Co., and will design and build special machinery and tools of all kinds.

V. C. KYLBERG, who was formerly assistant chief of the machine tool section of the Office of the Director of Sales, War Department, Washington, D.C., left this position on February 1, and has not yet definitely announced his plans for the future. Mr. Kylberg entered the machine tool section organized in March, 1919, and was largely responsible for many of the policies and practices adopted by this section, which later resulted in large sales of government-owned machine tools.

A. R. PETTERSON, formerly with the engineering department of the Osgood Bradley Car Co., of Worcester, Mass., is now chief engineer and director of production with the Allen-Spindle Corporation, Boston, Mass. Previous to his connection with the Osgood Bradley Car Co., Mr. Petterson was president and general manager of the Petterson Engineering & Mfg. Co., designer and builder of special machinery, tools, and jigs.

F. J. MAWBY, formerly with the sales force of Manning, Maxwell & Moore, Inc., New York City, has become a member of the sales organization of the Cincinnati Shaper Co. and the Cincinnati Gear-cutting Machine Co., Cincinnati, Ohio. During the war Mr. Mawby was engaged in engineering work in connection with the equipping of shops for making ammunition, guns, and gun carriages for both the United States and foreign governments, and was responsible for the development of a number of special machines for the rapid production of fuses.

G. M. EATON has been appointed chief mechanical engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. C. W. JOHNSON and H. W. COPE have been made assistant directors of engineering; C. H. CHAMPLAIN and E. S. MCCLELLAND, assistant works managers; JOHN E. BONHAM, assistant to works manager; and E. S. BRANDT, supervisor of equipment and methods. A. M. DUDLEY has been appointed manager of the automobile equipment department; R. P. JACKSON, manager of the material and process department; F. E. WYNNE, manager of the railway equipment department, and G. H. GARCELON, manager of the small motor department. C. B. AUEL has been made manager of the employes service department.

JOSEPH E. VINCENT, JR. has been appointed eastern sales representative of the Massillon Steel Castings Co., Massillon, Ohio, manufacturer of all kinds of steel castings, particularly those used in the automotive and railroad industries. Mr. Vincent is the owner and general manager of the Iron, Steel, Metal & Alloy Co., and also represents the Peerless Drawn Steel Co. and the Schwart-Herrmann Steel Works, Inc. He is located at 55 Liberty St., New York City, and in addition to the New York office a branch is maintained at 120 Franklin St., Boston, Mass., in charge of C. H. Dayton. It is the intention to open an office within the near future in Philadelphia to take care of the trade in Pennsylvania, Delaware, and Maryland.

OBITUARIES

JOHN NAZEL of the Nazel Engineering & Machine Works, Philadelphia, Pa., died at his home in Philadelphia, February 16.

PHILIP JOSEPH MCGUIRE, chief production manager of the Walter A. Wood Mowing & Reaping Machine Co., Hoosick Falls, N. Y., died February 14, from pneumonia, after a brief illness. Mr. McGuire had been connected with the company for fourteen years.

HAROLD MCGILL DAVIS, manager of the advertising department of the Sprague Electric Works of General Electric Co., New York City, died February 9 at his home in Brooklyn, N. Y., after an illness of about three weeks. He was born in Jerseyville, Ill., in August 1860. For four years he was advertising manager of a trade paper in New York and afterward became connected with an advertising agency, which he left to take the position occupied at the time of his death.

JOSEPH M. FLANNERY died February 17, at his home in Pittsburg, Pa. Mr. Flannery was one of the earliest users of vanadium in the manufacture of steel, and the first to produce radium in this country. During the war he supplied the Allies with radium for medical and other uses. He was president of the Standard Chemical Co. and of the Vanadium Chemical Co., and was also instrumental in the organization of several other companies, among which were the Flannery Bolt Co., the American Vanadium Co. and the Rosanoff Process Co.

KATHRYNE M. HAUN, treasurer of E. F. Houghton & Co., Philadelphia, Pa., died February 9, at her home in Philadelphia after a short illness from pneumonia. Miss Haun was born in Philadelphia in 1876. She had been associated with E. F. Houghton & Co. for twenty-five years, having entered the employ while still but a girl in a minor capacity, from which she rose by successive stages. When the company was incorporated in 1910 she was selected as the treasurer. She was one of the largest stockholders in the concern, which is engaged in the manufacture of industrial oils and leather goods.

COMING EVENTS

March 6-13—Second annual aeronautical exposition, held by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City, in the Seventy-first Regiment Armory, Thirty-fourth St. and Park Ave., New York City.

March 9-11—First Annual New England Industrial Accident Prevention Congress, held at Hotel Bancroft, Worcester, Mass.

March 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

April 19-22—Convention of the National Metal Trades Association at New York City; headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples Gas Bldg., Chicago, Ill.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore. Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

October 4-9—Annual convention and exhibit of the American Foundrymen's Association at Columbus, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Grove City College, Grove City, Pa. Bulletin containing catalogue for 1919-1920 with calendar and courses of study for the year.

Harvard University, Cambridge, Mass. Official register of the Harvard Engineering School for 1919-1920, containing calendar and courses of study.

United Engineering Society, 29 W. 39th St., New York City. Publication containing report of the Engineering Foundation, covering the organization, by-laws, policies, and work which it has accomplished.

BOOKS AND PAMPHLETS

Annual Report of the Smithsonian Institution for 1917. 674 pages, 6 by 9 inches. Published by the Smithsonian Institution, Washington, D. C.

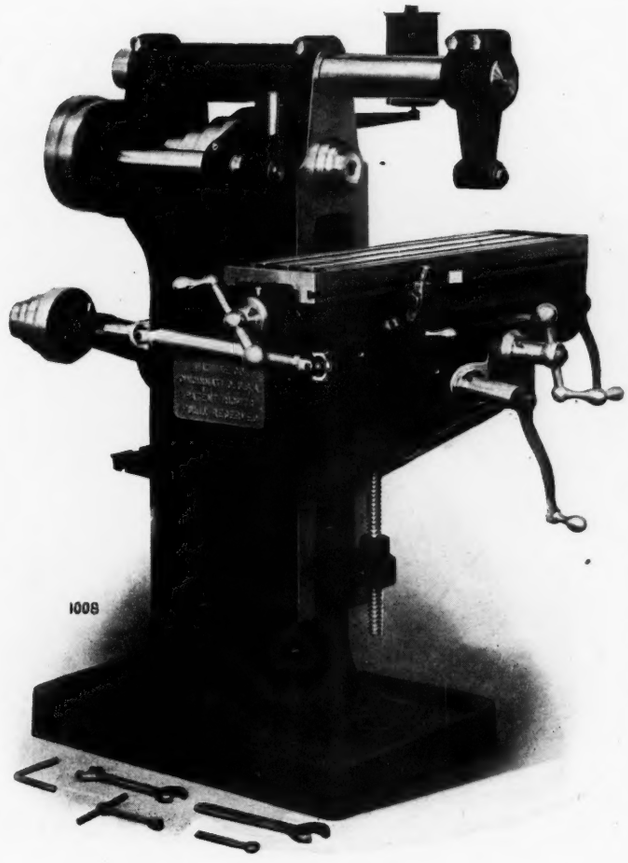
Specifications for the Manufacture and Installation of Railroad Track Scales. 35 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 83, of the Bureau of Standards. Price, 5 cents.

Proceedings of the Twenty-seventh Annual Convention of the Traveling Engineers' Association, held in Chicago, Ill., September 16 to 19, 1919. 366 pages, 5½ by 8½ inches. Edited by W. O. Thompson, secretary, Cleveland, Ohio.

Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots. By A. V. Bleininger. 52 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 144 of the Bureau of Standards. Price, 10 cents.

Developing a Gaging System for Interchangeable Manufacture. 55 pages, 6 by 9 inches; 72 illustrations. Published by the Pratt & Whitney Co., Hartford, Conn.

This book is an abstract of a series of articles by Erik Oberg, published in MACHINERY, describing the principles involved and the procedure followed in the development of a gaging system for interchangeable manufacture, based upon the experience of the Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work. While the gaging systems described were designed particularly for arsenals, it is evident that the principles laid down are applicable to interchangeable manufacture of any kind.



Back Geared.
Screw Feed.
Hand Quick Return.
Crank Handles for All Movements.
Wide Speed Range—21 to 500 r. p. m.
Power Longitudinal Feed.
Range—18" x 6" x 15".

Why Not Get Acquainted!

The 18" Back Geared Cincinnati Plain Miller, for work in its field, will prove equally as profitable as the well-known Cincinnati High Power and Cincinnati Automatic Millers.

Built with
The same painstaking workmanship.
The same complete jigging and tooling.
The same exact gauges and inspection standards.

It will pay to get acquainted. Write now.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI **OHIO, U. S. A.**

The Helical Gear. 43 pages, 6 by 9 inches. Published by the Fellows Gear Shaper Co., Springfield, Vt.

This is a treatise covering the application of helical or twisted teeth to gears operating on parallel axes. It contains data on the design, application, and methods of cutting gears of this type. The book is divided into four chapters, headed as follows: Principle of the Helical Gear; Design of Helical Gears; Strength of Helical Gear Teeth; and Cutting Helical Gears.

Readjustment and Reconstruction Information. 371 pages, 6 by 9 inches. Published by the United States Council of National Defense, Reconstruction Research Division, Washington, D. C.

The book is the second of a series of reconstruction and readjustment reports compiled by the council's research staff, which is now closing this field of work and directing its activities solely to peace-time national defense research. The subjects dealt with include Americanization; assistance for service men and their families; building activities, including housing; community councils; employment; highways; land settlement; state councils of defense; public works; and vocational education for returned service men.

Safety Fundamentals. 228 pages, 5½ by 8 inches; illustrated. Published by the Safety Institute of America, 261 Madison Ave., New York City, Price, $2.

This book comprises a collection of free lectures given under the auspices of the Safety Institute of America to safety inspectors of New York and New Jersey, to enable them to enlarge their knowledge and broaden their experience. The book also includes the discussions that followed these lectures. The subjects covered are as follows: The Body Which Gets Hurt; the Injured Body and Its Treatment; Protective Clothing for Men; Suitable Work Garments for Women in Industry; Safe Heads and Good Eyes; Guarding Machinery; Arrangement of Machinery and Working Places; Heating and Ventilation; Illumination; Nature's Forces for and against Workmen; and Safety Education and Shop Organization.

Little Known Facts about Grinding and Grinding Kinks. By Howard W. Dunbar. 174 pages, 5 by 7 inches. Published by the Norton Co., Worcester, Mass.

This book contains a series of articles reprinted from "Grits and Grinds," treating of commonplace facts concerning grinding. The scope of the book is indicated by a few of the subjects contained therein, which are as follows: Belting; truing the wheel; lubricant; cam checking; surface grinding; wheel grades; form grinding; wheel speeds; cam grinding; grain size; wheel dressing and truing; wheel balance; soft wheels; wheel feeds; hand grinding and machine grinding; wheel service in cylindrical grinding; depth of cut; diamond holders; piston grinding; valve seat grinding; grinding shells; grinding tubes, etc. The book is well illustrated and should be of interest to all those who are interested in the proper use of grinding wheels and machines.

Mechanical Drafting Manual—Parts 1 and 2. By Charles B. Howe. Loose-leaf sheets, 8½ by 6½ inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, 50 cents for each part.

This work consists of a series of exercises in drawing, arranged in the form of lessons as an aid in teaching the subject. Each lesson is developed as the logical step in advance of the one preceding. The sequence of lessons given by the author is the result of many years of experience and experimentation. Part 1 covers the general principles of drafting and working drawings, including representation of objects by lines and views, lettering, isometric drawing, inking and tracing, etc. Part 2 is devoted to the geometry of drawing, including geometrical constructions of solids; surfaces, points and lines; development of the prism and cylinder, pyramid and cone, prism and pyramid, oblique cone, etc.

Complete Practical Machinist. By Joshua Rose. 547 pages, 5¼ by 7½ inches; 432 illustrations. Published by Henry Carey Baird & Co., Inc., 116 Nassau St., New York City. Price, $3.

This is the twentieth edition of a well-known book embracing lathe work, vise and bench work, drills and drilling, taps and dies, hardening and tempering, making and use of tools, tool grinding, marking out work, lathe attachments and their uses, machine tools, etc. The work has been enlarged and revised in order to include the latest and most improved practice. The most noteworthy feature of the new edition is the introduction of several chapters on machine tools and their attachments, previous editions of the work having treated of the cutting tools only. The book is written for the practical workman in the language of the work-shop. Full instructions are given on the use of all kinds of metal-working tools, both hand and machine. The material is divided into twenty-five chapters, headed as follows: Cutting Tools for Lathes and Planing Machines; Cutting Speed and Feed; Boring Tools for Lathe Work; Screw-cutting Tools; Lathe Dogs, Carriers or Drivers; Turning Eccentrics; Hand-turning; Drilling in the Lathe; Boring-bars; Slotting Machine Tools; Twist Drills; Tool Steel; Taps and Dies; Vise Work—Tools; Fitting Connecting-rods; Milling Machines and Milling Tools; Grindstone and Tool Grinding; Lining or Marking out Work; Machine Tools; Precision Lathe Attachments and Their Use; Fellows Gear Shaper and its Operation; Miscellaneous Attachments and Machinery; To Calculate the Speed of Wheels, Pulleys, etc.; How to Set a Slide Valve; and Pumps.

Hendricks' Commercial Register of the United States for Buyers and Sellers. Twenty-eighth annual edition, 1919-1920. 2703 pages, 7½ by 9½ inches. Published by the S. E. Hendricks Co., Inc., 2 W. 13th St., New York City. Price, $12.50.

This is the twenty-eighth annual edition of this well-known directory for buyers and sellers. The present volume has been thoroughly revised and contains many new listings. Several new features have been incorporated in this edition, the most noticeable among which is the method of exterior indexing by coloring the front edges of the pages red, white, and blue to facilitate reference to the different main sections of the book. The first section, the pages of which are colored blue on the front edges, contains the trade index, covering 162 pages, in which every product listed in the book is indexed and cross-indexed for ready reference. The red section following, is the main classified trades list, and contains 1813 pages, listing over 18,000 different products. In the present edition there are over 1200 new headings, including many completely covering the chemical industry. The white section of the book, containing 216 pages, lists the trade names under which the products are manufactured and gives names and addresses of the manufacturers. Following the trade names section there is another blue section covering 487 pages which contains an alphabetical list of the names of all the manufacturers in the book, together with a list of their addresses and their main line of business. This is followed by an index to the advertisers of 20 pages, containing a full list of the branch and foreign offices of each firm. The list of trade headings covers all products—from the raw material to the finished article—connected with the electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, commercial, railroad, steel, architectural, contracting, and kindred industries, and the firms listed include producers, manufacturers, dealers, and consumers. This directory is therefore of the greatest value to purchasing and sales departments, as well as to those who find it necessary to compile lists of manufacturers of various kinds of machinery.

NEW CATALOGUES AND CIRCULARS

Lowell Wrench Co., Worcester, Mass. Catalogue giving dimensions, prices, etc., of reversible ratchet wrenches, die-stocks and drills.

Moline Tool Co., Moline, Ill., manufacturer of multiple drilling machines and cylinder boring machines, is distributing a calendar for 1920 to the trade.

Swan & Finch Co., 165 Broadway, New York City. Calendar for 1920, advertising the oils, greases, and other lubricants produced by this company.

Bowen Products Corporation, Auburn. N. Y. Catalogue 7, of "Empress" oil-cups and grease cups, giving sizes, threads, and list prices for the complete line.

L. S. Starrett Co., Athol, Mass., has issued a pamphlet containing new list prices for the Starrett catalogue 21, superseding the revised list prices dated July 31, 1919.

Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills, reamers, wrenches, and drop-forgings, has issued a calendar for 1920, calling attention to the company's products.

R. S. Stokvis & Zonen, Ltd., of Rotterdam, Holland, dealers in machine tools, whose New York office is at 17 Battery Place, have issued and are distributing to the trade, a calendar for 1920.

Mahr Mfg. Co., Minneapolis, Minn. Circular of the "Jiffy" torch, of the compressed air and self-contained types for cupola lighting, ladle drying, mold drying, preheating, and general foundry purposes.

U. S. Gutta Percha Paint Co., Providence, R. I. Pamphlet entitled "More Light," illustrating factory interiors that have been painted with "Barreled Sunlight," to increase the illuminating efficiency.

Towmotor Co., Bliss Road, Cleveland, Ohio. Bulletin 2, descriptive of the "Towmotor"—a gasoline industrial tractor which has a capacity for heavy loads and at the same time operates economically on light loads.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. Bulletin 49, containing illustrations of a number of types of W-S-M car dumpers, and showing blueprints of these machines. Copies will be sent free upon request.

Walworth Mfg. Co., Boston, Mass. Circular entitled "Some Remarks from Dan McGann," containing a poem by Edgar A. Guest having Americanism for the theme. The company will furnish copies upon request.

Merchants & Manufacturers Exchange, Grand Central Palace, New York City. Pamphlet containing a classified list of products exhibited at the International Exposition of Industries in the Grand Central Palace.

Automatic Machine Co., Bridgeport, Conn. Circular illustrating and describing the Automatic hob thread milling machine—a machine of the multiple cutter type for producing internal and external threaded work.

Norton Co., Worcester, Mass. Pamphlet entitled "Norton Service," containing a reprint of papers briefly outlining the service, employment, medical, safety, recreation, cooperative gardening, and housing activities of the company.

Dayton Reliance Tool & Mfg. Co., Dayton, Ohio. Circular illustrating the Dayton "Quick-change" chuck, which it is claimed can be reset in one minute and twenty seconds. These chucks are made in two-jaw universal and four-jaw independent styles.

Electric Furnace Co., Alliance, Ohio. Booklet 8-B, showing installations of Baily electric furnaces for melting non-ferrous metals, which are built in sizes having electrical capacities from 50 to 1000 kilowatts, and hearth capacities from 300 pounds to 40 tons.

Hall Gas Engine Co., Bridesburg, Philadelphia, Pa. Circular illustrating and describing the Hall planetary thread milling machine for milling both internal and external threads. The machine is made in 6- and 12-inch sizes, and is arranged for either belt or motor drive.

Mehl Machine Tool & Die Co., Roselle, N. J. Calendar for 1920, advertising the company's tool service in jigs, fixtures, dies, gages, special machines, tool and machine designing, and pattern-making, illustrating some of the tools, devices, and machines built by the company.

Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York City. Circular entitled "W. C. K. City," which reproduces a composite photograph of some of the many plants erected by the company, indicating the wide scope of engineering and construction work engaged in.

Bristol Machine Tool Co., Bristol, Conn. Catalogue illustrating this company's line of hand milling machines, vertical milling machines, rotary piston ring grinders and rotary precision surface grinders. Specifications are given for the various machines and the construction details are described.

Smalley-General Co., Inc., Bay City, Mich. Circular describing different methods of chucking and chucks in use on Smalley-General thread milling machines. Bulletin G, showing examples of work produced on the Smalley-General thread milling machine, and giving milling time and other related data.

Landau Machine & Drill Press Co., Inc., 19-25 W. 44th St., New York City. Circular descriptive of the Landau combination drill chuck and tapping device, which is equipped with four spindles for performing drilling, tapping, reaming, and countersinking operations without removing the work from the table.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular entitled "Prepare for More Business," illustrating the tooling equipment for machining flywheels on Gisholt turret lathes. Circular entitled "Throw in the Gears with Periodograph Control," advertising the use of the "Periodograph" for making cost records.

George C. McKay & Co., 1046 St. Clair Ave., Cleveland, Ohio. Circular descriptive of the portable electrical screwdriver made by the Automatic Electrical Tool Co., Cincinnati, Ohio. This screwdriver is fitted with right- and left-hand spindles, so that the same machine can be used for driving and removing the screws.

Hauck Mfg. Co., 101-113 Eleventh St., Brooklyn, N. Y. Bulletin 119, illustrating and describing in detail the many different types of oil burners manufactured by this company. The book contains illustrations showing the application of the Hauck burners to various types of furnaces as well as other methods of using the burners. Copies will be sent upon request.

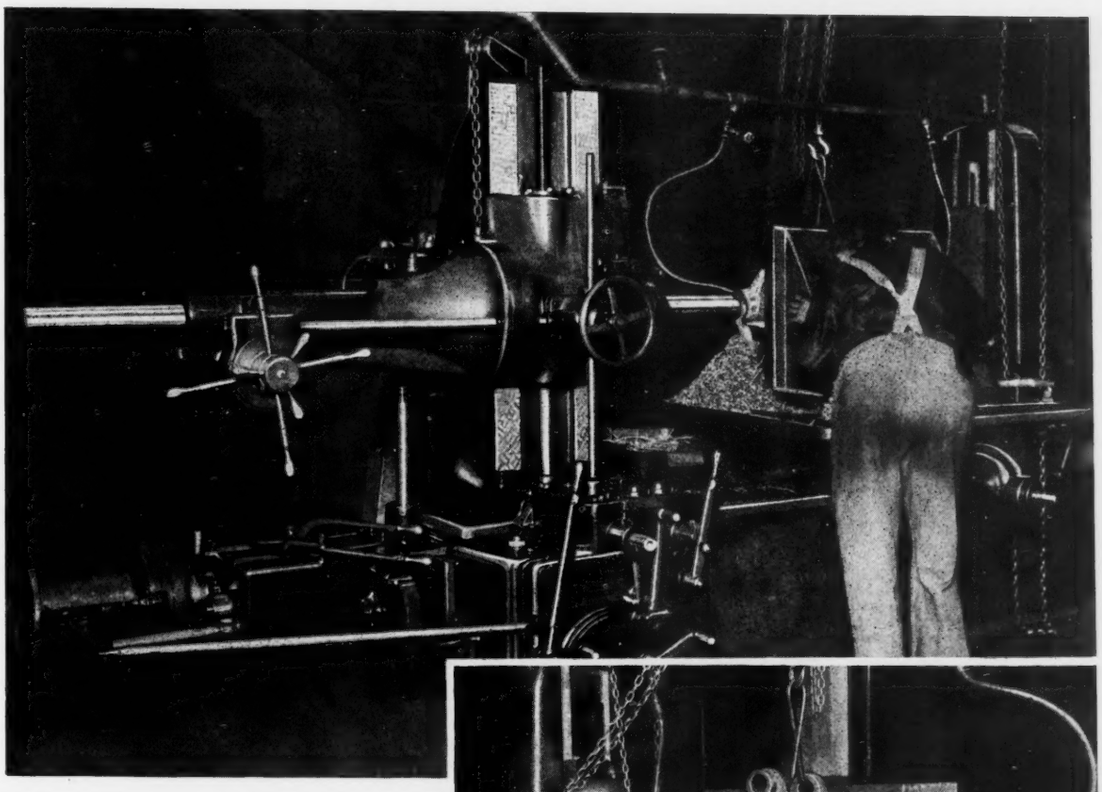
Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalogue of Beaudry power hammers of the "Champion" type, which are built in two styles—belt and motor driven—in sizes from 50 to 500 pounds weight of ram. These machines are designed for light and heavy railroad, machine, and general blacksmithing, and for swaging, collaring, drawing, and general manufacturing.

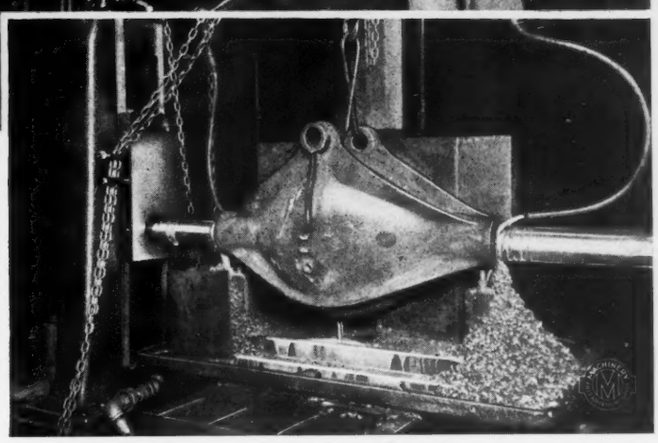
Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue of metal-working machinery, illustrating and describing milling machines made by the Kearney & Trecker Co., Milwaukee, Wis.; shaping machines made by Gould & Eberhardt, Newark, N. J.; drilling machines made by the Turner Machine Co., Danbury, Conn.; and Grinding machines made by the Gardner Machine Co., Beloit, Wis.

T. C. Dill Machine Co., Philadelphia, Pa. Catalogue illustrating the many uses of the Dill slotter. The book contains a large number of views showing this machine engaged on a wide variety of work from the heaviest machining operations to the lightest. The catalogue also describes the construction of these machines and gives a list of the principal dimensions.

Sherritt & Stoer Co., Philadelphia, Pa. Calendar for 1920, illustrating and briefly describing the important features of the line of machine tools handled by the company, including heavy-duty planers, crank shapers, horizontal boring and milling machines, steam hammers, power presses, drilling machines, vertical boring and turning mills, milling machines, slotters, lathes, and grinding machines.

SIX LUCAS
"PRECISION" BORING MACHINES
On Pierce-Arrow Truck Parts





Accuracy Is of Prime Importance

The six machines referred to are all in one department of the Pierce-Arrow shops at Buffalo, N. Y.—the first having been installed eight years ago. They are used mainly for boring steel castings—gear cases, gear case covers and axle housings such as the one here set up, in which the holes are 4″ diameter, 8″ long.

Two sizes of boring bars are used—the first roughing out about ¼″ of stock around the holes and the second finishing them to plus and minus limits of 3.996″ and 3.994″. Though accuracy is the important feature of this operation, an output of 19 pieces finished in 8 hours is sufficiently good to further recommend these machines for careful investigation.

Send for the Catalog.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

J. E. Martin Tool & Die Co., 548 W. State St., Springfield, Ohio. Circular illustrating and describing the "Gem" drilling machine vise, equipped with a handwheel which provides for rapid adjustment of the jaws. The vise has an independent swivel jaw, adapting it for holding taper work, and one of the jaws is provided with two V-grooves for holding round or irregular shaped pieces.

Reed Small Tool Works, Cherry and Vine Sts., Worcester, Mass., is issuing a new catalogue, No. 4, of 40 pages, 5¼ by 7½ inches in which a revision of list prices is noted. The booklet covers the Reed line of micrometers more fully than the descriptive matter heretofore issued and shows a greatly broadened line. The company is also issuing display calendars, 11 by 5 inches in size, to the trade.

Electric Furnace Co., Alliance, Ohio, is issuing a new monthly publication entitled "The Electric Furnace," containing information relating to the electric furnace industry and particularly to the Baily type of furnace produced by this company. The aim is to bring to the attention of the public the various operations that lend themselves to electric furnace applications and the commercial economies effected thereby.

Wilton Tool & Mfg. Co., Boston, Mass. Catalogue 22, descriptive of the Wilton master gage blocks which are guaranteed to be accurate within 0.00001 inch. These blocks are made in various sets covering the requirements of different manufacturing shops and conditions. They constitute a complete equipment of standards by means of which any dimensions can be obtained for laying out, measuring and inspecting work.

E. C. Atkins & Co., Inc., Indianapolis, Ind. Catalogue 18, covering the complete line of saw tools and mill specialties made by this concern, which includes circular saws, wabble saws, grooving saws, box board, matcher cutters, inserted-tooth saws, band saws, scroll saws, swages, files, punches, mandrels, grinders, knives, metal-cutting machines, cross-cut saws, saw vises, and silver steel saws for use in manual training schools, etc.

James H. Matthews & Co., 3946 Forbes Field, Pittsburg, Pa. Catalogue 85, of Matthews steel dies and stamps for marking products in order to identify them. The pamphlet illustrates the different styles of stamps and dies made by the company and shows their application for marking various types of products. The Matthews "Quantitag" and "Unitag" machines for embossing metal shipping tags are also illustrated and described.

Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa. Catalogue illustrating and describing a line of time- and labor-saving machinery for use in railway shops, shipyards, general machine shops, and miscellaneous industrial plants. Among the machines shown are portable boring-bars, floor-plate boring-bars, portable floor boring machines, column boring machines, trepanning machines, duplex boring machines, tube boring and facing machines, portable crankpin turning machines, portable milling machines, pipe-bending machines, etc.

Clark Equipment Co., Buchanan, Mich., has published a pamphlet containing a reproduction of the Constitution of the United States. The booklet is illustrated with pen portraits of American patriots and sketches of the plant of the Clark Equipment Co. It is believed that in this period of unrest it would be of benefit to all to become acquainted with the principles of equity and justice upon which our Government was founded. These principles were used as the basis for the system of industrial democracy installed in the plant of the Clark Equipment Co., and described in the February number of MACHINERY.

TRADE NOTES

Aux Forges de Vulcain, 3 Rue St. Denis, Paris, France, announces that its New York office is now located at 21 E. 40th St., and all correspondence should be sent to the new address.

Fenn Mfg. Co., Hartford, Conn., announces its business is now being run as a corporation instead of a partnership as formerly. No change has been made in the management, personnel, or business methods.

Turbine Air Tool Co., 301 Chamber of Commerce Bldg., Cleveland, Ohio, has developed and is making a complete line of pneumatic tools, and solicits catalogues for its purchasing and engineering departments.

Sherritt & Stoer Co., Inc., has opened a new office, store-room and warehouse at 2006-2008 Market St., Philadelphia, Pa., where a permanent exhibition of machine tools, and railway and machine shop equipment will be maintained.

Sterling Products Co., manufacturer of drills, vises, and other tools, and the **Morgan Vise Co.,** have removed from Machinery Hall to 35-37 S. Desplaines St., Chicago, Ill., where they have display rooms located on the street floor.

Cincinnati Shaper Co., Cincinnati, Ohio, manufacturer of shapers and gear-cutting machines, is erecting a large addition to its plant, which will double the present capacity. The new building is expected to be ready for occupancy April 1.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., held a general conference of executives, plant and branch managers, and salesmen, at its Detroit plant, Second Ave. and Amsterdam St., on the occasion of the opening of a five-story addition.

Precision & Thread Grinder Mfg. Co., 1932 Arch St., Philadelphia, Pa., manufacturer of the "Multigraduated" precision grinder, has appointed the **Gardner-Bryan Co.,** of Cleveland, Ohio, as its special representative in Ohio, Indiana, and western Pennsylvania.

Puritan Machine Co., 390 W. Fort St., Detroit, Mich., has recently opened a two-story shop, 120 by 50 feet, for the manufacture of automobile parts, and has installed gear-cutting machinery for cutting its own gears. W. H. Robinson is superintendent of the shop.

Willson Goggles, Inc., formerly T. A. Willson & Co., Inc., Reading, Pa., announces that the firm has established a New York branch office on the 19th floor of the Bush Terminal Sales Building, 42nd St., near Broadway. The manager of the New York branch is William Wortman.

Cincinnati Pulley Machinery Co., has changed its name to the Avey Drilling Machine Co. No change has been made in the stockholders, management, personnel, or activities of the organization in any way. Future communications should be addressed to the new name of the company.

Morris Machine Tool Co., Cincinnati, Ohio, has bought the entire assets of the **American Metal Products Co.,** which will hereafter be known as the Metal Products Department of the Morris Machine Tool Co. The plant has been moved into new quarters on the property of the J. B. Morris Foundry Co.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., has established a permanent office and show-room at 1436 S. Michigan Ave., Chicago, Ill. The office will be in charge of R. G. Ames, whose territory has been extended to cover the entire Middle West. F. E. Marrion and J. N. LaBelle will assist Mr. Ames.

Thompson Grinder Co., Springfield, Ohio, is erecting a new plant on West Main St. The building is to be 65 by 200 feet, one-story, of concrete and steel sash construction. One end will be devoted to the office requirements and the remainder will be given over to the manufacture of the line of precision grinding machines on which this company has specialized for years.

Tacony Steel Co., Tacony, Philadelphia, Pa., is opening a sales office in the Marquette Building, Chicago, Ill. Frank B. Hillwick, until recently with the Crucible Steel Co., is district sales manager. Mr. Hillwick was formerly with the Bethlehem Steel Co., and has had considerable practical experience in machine shops and heat-treating departments. He is a member of the American Steel Treaters Society.

Electrolabs Co., 2635 Penn Ave., Pittsburg, Pa., has decided to consolidate all its offices at the address given in order to obtain closer cooperation between the factory and the sales department. The company requests that all correspondence be addressed to the Pittsburg office and be marked for the attention of the proper department. The firm will maintain a branch office at 30 Church St., Room 313, New York City.

Kearney & Trecker Co., Milwaukee, Wis., has opened a new office and show-room at 738 Superior Ave., N. W., Cleveland, Ohio, in order to take care of its constantly increasing business in the Ohio territory. A representative line of Milwaukee milling machines, attachments, and accessories will be carried at the new office. C. J. Sturgeon, formerly with the W. M. Pattison Supply Co., will be in charge of sales in the Ohio territory.

Production Engineering Co., 212 Center St., New York City, has been organized for the designing and building of tools, gages, and special machinery, thereby aiding manufacturers to increase production by the use of proper tools, gages, and manufacturing equipment. The following men having a long and varied experience as tool-makers, designers, and engineers, are connected with the company: Robert Steinman, John A. Honegger, and H. Allen Hinchcliff.

Plant Engineering & Equipment Co, Inc., 192 Broadway, New York City, manufacturer of Corliss valve steam traps, Mason condensation meters, and other power and heating specialties, announces the opening of its twenty-sixth office, at Newark, N. J., to care for the increasing demand for its product. M. William Ehrlich, consulting and contracting engineer, will be the New Jersey manager with headquarters at Newark and a sub-office at Lyndhurst, N. J.

DeLaval Separator Co., Poughkeepsie, N. Y., has placed a contract with the John W. Ferguson Co. of Paterson, N. J., for the immediate erection of a one-story and basement power machine building, 150 by 150 feet, having a floor area of 48,000 square feet. The new building will have brick walls and steel sash throughout and will have reinforced concrete floor-beams and stairs. The roof will be of the sawtooth type covered with asbestos asphalt.

Walter Engineering Co., 520-530 Lindsay Bldg., Dayton, Ohio, has been started by Frank L. Walter who was formerly connected with the Dayton Engineering Laboratories Co. as master mechanic and previous to that with the National Cash Register Co. in its designing department. The new concern will design and build special machinery and tools of all kinds, and will operate pattern-making and tool-building shops in connection with its designing department.

W. A. Wilson Machine Co., manufacturer of iron planers and special machinery, which has been located in Rochester, N. Y., for thirty-five years, has been sold to the **Morley Machinery Corporation,** 215 N. Water St., Rochester. The new company will continue the manufacture of the Wilson planers, and is engaged in installing new equipment to increase its output. The owners are C. F. Morley, formerly vice-president of the Symington Machine Corporation, and J. S. Armstrong, formerly secretary of the W. A. Wilson Machine Co.

Nelson Tool & Machine Co., 253 Norfolk St., Newark, N. J., has recently been incorporated and will move about April 1, to its new plant at 82-88 Lewellyn Ave., Bloomfield, N. J. The constantly increasing demand for the company's products, which include angle-plates, universal angle fixtures, and work-holding devices, has made larger quarters necessary. New equipment and machines will be installed with a view to securing maximum production on an interchangeable basis. The total floor space of the plant will be 16,000 square feet on two floors.

Hauck Mfg. Co., 101-113 Eleventh St., Brooklyn, N. Y., announces that the Hauck Burner Service Station at Pittsburg has moved its office from 2930 Penn Ave. to 105 Wood St., where their enlarged facilities will enable them to give better service to their customers in that vicinity. The Hauck Burner Service Station at Boston has moved from 70 High St. to larger quarters at 149 Berkeley St., corner Columbus Ave. The new office consists of a large display window, store, office, and space for demonstration. The Hauck Burner Service Station at Cleveland has moved from 2114 Superior Viaduct to 1106 Walnut Ave., where the representative is in a better position to make demonstrations and render more efficient service.

Gage Engineering Service Co., Kellogg Bldg., 1422 F St., N.W., Washington, D. C., has been organized by A. E. Hanson, J. A. Haigh, and I. H. Fullmer, to engage in consulting and contracting service, including the design and installation of limit gaging systems and inspection methods; standardization; interchangeable manufacture; tool and production efficiency; and technical investigations. The firm will contract for gages; inspection equipment; tools and dies; and jigs and fixtures. The personnel of the company has been associated with the Gage Section of the Bureau of Standards since its organization in 1917. The combined experience of these men covers all phases of the work of the Bureau of Standards in administration, research, design, gage manufacture and salvage, and instrument construction.

Frasse Steel Works, Inc., Hartford, Conn., has been incorporated under the laws of Connecticut with a capitalization of $1,000,000, and has taken over the business of the Peter A. Frasse Co., of 417 Canal S., New York City. The new company has completed plans for the reconstruction of the present plant to provide sufficient space to care for the increased business of the company. The additions to the plant will comprise an extension to the present shop building of 25 by 320 feet, and the construction of a three-story building, 90 by 175 feet. It is expected that the expansion will enable the company to increase its output from 26,000 tons a year to 50,000 tons a year. The Frasse Steel Works will handle the sales in New England, while the original New York company—the Peter A. Frasse Co.—will act as sales agent for the remainder of the country.

Square D Co., Detroit, Mich., manufacturer of electrical safety devices, announces the following additions and changes in its sales and advertising departments: E. A. Printz, formerly district sales manager of the Chicago territory, has been made sales manager, A. MacLachlan, continuing in the capacity of secretary and director of distribution; D. M. Stone, formerly district sales-manager of the Pittsburg territory, has been made district sales manager of the Detroit territory; J. A. Jaques, formerly in charge of the New York territory as district sales manager, has been given the district sales managership of the Pittsburg territory, and H. W. Spahn, district sales manager of the Buffalo territory, has been placed in charge in New York; D. H. Colcord, formerly of the department of publicity of the Westinghouse Air Brake Co. of Pittsburg, has been appointed director of research engineering.

Springfield Automatic Screw Machine Corporation of Springfield, Mass., has been organized to take over the business of the P.W.V. Automatic Machine Corporation of Fitchburg, Mass. The present officers of the P.W.V. Automatic Machine Corporation will remain with the new company with the addition of I. T. McGregor, who will become treasurer of the Springfield concern. The other officers are: C. E. Van Norman, president; F. H. Page, vice-president; M. A. Coolidge, vice-president; Clarence J. Wetsel, general manager, secretary and assistant treasurer; and L. M. Waite, vice-president and sales manager. The board of directors consists of: C. E. Van Norman, F. H. Page, I. T. McGregor, Clarence J. Wetsel, and A. J. Skinner, of Springfield, Mass.; M. A. Coolidge and L M. Waite of Fitchburg, Mass.; and Ashton L. Carr, H. Douglas Williams, Eugene E. Reed, and Alton T. Tupper of Boston, Mass. The company will erect a modern plant in Springfield, Mass., this spring for the manufacture of its line of "Radical" automatic screw machines, and will also continue to keep its Fitchburg plant in operation. The main office, however, will be located in Springfield.